Data-moderate stock assessments for brown, China, copper, sharpchin, stripetail, and yellowtail rockfishes and English and rex soles in 2013

by

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Executive Summary

Stocks

The catch and index only stock assessment methods (XDB-SRA and exSSS) were applied to eight species of groundfishes. Six were rockfishes (three nearshore and three shelf and/or slope species) and two flatfishes. Two of the nearshore rockfishes (China and copper) assessments defined and assessed stocks in two areas, the former north and south of Cape Mendocino, CA and the latter north and south of Point Conception, CA. Yellowtail rockfish was also considered as two stocks north and south of Cape Mendocino, but only the northern stock was assessed. The remaining rockfishes and two flatfishes were treated as coastwide stocks.

Derived outputs

All stocks were found to be above the biomass limit reference points. No stocks were therefore found to be overfished, but at least one (China rockfish north) is below the target reference point. Overfishing may also be occurring on that stock. Estimated population biomass of the nearshore rockfishes with assessments using fishery-dependent data demonstrated less uncertainty than the shelf and slope species with assessments using fishery-independent survey data. Overall exploitation rates were smaller than that estimated by F_{MSY}. Given the high stock status of the shelf-slope species, the estimated OFLs are high and well above average catch over the last 3 years.

Table ES1. Derived outputs for each assessed stock. Central tendency is reported as the median. Numbers in parentheses are 95% credibility intervals. * OFL estimates for Copper rockfish North and South of 40°10′ N. lat. are a post-stratification of assessment results based on cumulative removals by area, 1916-2012.

				Derived Outputs: Scale and Status			
Model	Group	Stock	Area	SB_0	SB_{2013}	SB_{2013}/SB_0	SB_{MSY}
XDB-SRA	Rockfishes	Brown rockfish	Coastwide	1794 (977 - 3732)	727 (333 - 2285)	0.42 (0.22 - 0.77)	718 (391 - 1493)
XDB-SRA	Rockfishes	China rockfish	N. of 40°10' N lat.	243 (127 - 542)	84 (22 - 366)	0.37 (0.12 - 0.73)	97 (51 - 217)
XDB-SRA	Rockfishes	China rockfish	S. of 40°10' N lat.	405 (232 - 1272)	264 (138 - 925)	0.66 (0.4 - 0.93)	162 (93 - 509)
XDB-SRA	Rockfishes	Copper rockfish	N. of 34°27' N lat.	1704 (1081 - 2734)	795 (417 - 1694)	0.48 (0.26 - 0.85)	681 (433 - 1093)
XDB-SRA	Rockfishes	Copper rockfish	S. of 34°27' N lat.	942 (545 - 2745)	699 (351 - 2189)	0.76 (0.43 - 0.99)	377 (218 - 1098)
exSSS AIS	Rockfishes	Sharpchin	Coastwide	7887 (2437-24724)	4947 (1456-21157)	0.680 (0.31-0.91)	1944 (634-6509)
exSSS AIS	Rockfishes	Yellowtail (N)	N. of 40°10' N lat.	82974 (19363-277492)	50043 (12184-221920)	0.667 (0.35-0.90)	19020 (4617-70550)
exSSS AIS	Flatfishes	English sole	Coastwide	29238 (11757-94321)	25719(10444-89100)	0.879 (0.77-0.96)	4898 (1019-18983)
exSSS AIS	Flatfishes	Rex sole	Coastwide	3808 (731-15814)	2966 (602-13150)	0.800 (0.64-0.93)	560 (255-3418)

				Derived Outputs: Fishing and Removals			
Model	Group	Stock		F_{2012}/F_{MSY}	MSY	OFL_{2015}	OFL_{2016}
XDB-SRA	Rockfishes	Brown rockfish	Coastwide	0.63 (0.27 - 1.47)	149 (109 - 196)	166 (69 - 364)	162 (66 - 361)
XDB-SRA	Rockfishes	China rockfish	N. of 40°10' N lat.	2.15 (0.49 - 11.29)	9 (3 - 20)	7 (1 - 35)	7 (1 - 36)
XDB-SRA	Rockfishes	China rockfish	S. of 40°10' N lat.	0.27 (0.13 - 0.58)	32 (22 - 50)	55 (25 - 108)	53 (23 - 104)
XDB-SRA	Rockfishes	Copper rockfish	N. of 34°27' N lat.	0.34 (0.15 - 0.87)	114 (75 - 148)	145 (56 - 314)	141 (52 - 308)
XDB-SRA	Rockfishes	Copper rockfish	S. of 34°27' N lat.	0.32 (0.16 - 0.86)	84 (51 - 136)	167 (59 - 303)	154 (54 - 287)
XDB-SRA	Rockfishes	Copper rockfish	N. of 40°10' N lat.	--	--	11*	10*
XDB-SRA	Rockfishes	Copper rockfish	S. of 40°10' N lat.	--	--	301*	284*
exSSS AIS	Rockfishes	Sharpchin	Coastwide	0.02	320 (154-883)	416 (130-1474)	404 (132-1397)
exSSS AIS	Rockfishes	Yellowtail rockfish	N. of 40°10' N lat.	0.11	5728 (3295-14517)	7218 (2646-23903)	6949 (2679-22724)
exSSS AIS	Flatfishes	English sole	Coastwide	0.013	4072 (3210-11847)	10792 (7138-32391)	7890 (4921-23317)
exSSS AIS	Flatfishes	Rex sole	Coastwide	0.07	1676 (1230-3622)	5764 (3089-16500)	3956 (2479-10253)

Decision tables

Forecasts for each stock are based on a 12-year outlook predicated on one of two control rules: 1) constant catch based on the average of the last three years or landings and 2) catch based on the P* OFL buffer and the “40-10” ABC control rule. The latter has three catch scenarios based on the forecasted results of the three states of nature. These states of nature capture different states in depletion by taking the median value of starting depletion and resultant median forecasted catch under control rule 2 above and the base case model for the following portions of the posterior depletion distribution: 1) bottom quartile of starting depletion values, 2) interquartile of the starting depletion, and 3) upper quartile of the starting depletion. Thus 25% of the distribution is in each of the lower and upper states of nature, with 50% contained in the middle state. A total of three models were therefore run with the three different catch scenarios based on control rule #2, then each state of nature (posterior density quartiles) was summarized by the median value of the draws contained in that state of nature. Each forecast assumes full attainment of the prescribed catch and no implementation error.

Nearshore rockfishes

Decision tables for the nearshore rockfish stock assessments are given in Tables ES2 through ES6 (Post-STAR panel base case only). See Tables 65-69 for alternative states of nature presented during the STAR Panel. Differences between Tables 65-69 and the final base case (Tables ES2-ES6) are minor, and qualitative patterns among alternative states of nature remain unchanged.

Table ES 2. Decision table for brown rockfish (coastwide) base model. Alternative catch streams are median ABC catch projections (mt) with 40-10 adjustment based on quartiles of depletion in 2013. Median MSY is 149 mt/year.

	Year	Catch	Spawning Biomass	Depletion
Mgmt. Action: Avg. Catch 2010-2012	2013	101.5	727.2	0.417
	2014	101.5	744.2	0.428
	2015	101.5	761.9	0.439
	2016	101.5	779.6	0.449
	2017	101.5	795.6	0.460
	2018	101.5	813.4	0.470
	2019	101.5	829.9	0.481
	2020	101.5	846.5	0.492
	2021	101.5	863.1	0.502
	2022	101.5	879.9	0.512
	2023	101.5	895.1	0.521
	2024	101.5	910.6	0.531

	Year	Catch	Spawning Biomass	Depletion
Mgmt. Action: Low Catch	2013	101.5	727.2	0.417
	2014	101.5	744.2	0.428
	2015	80.7	761.9	0.439
	2016	85.7	790.0	0.455
	2017	89.7	812.8	0.470
	2018	93.3	834.0	0.482
	2019	97.0	851.1	0.494
	2020	99.9	868.1	0.504
	2021	102.6	884.4	0.515
	2022	105.3	901.1	0.524
	2023	107.8	913.5	0.533
	2024	110.3	923.8	0.541

	Year	Catch	Spawning Biomass	Depletion
Mgmt. Action: Median Catch	2013	101.5	727.2	0.417
	2014	101.5	744.2	0.428
	2015	149.0	761.9	0.439
	2016	147.7	755.8	0.435
	2017	147.4	752.2	0.433
	2018	147.5	751.4	0.434
	2019	148.3	754.1	0.437
	2020	148.7	753.5	0.438
	2021	148.7	754.0	0.438
	2022	148.7	753.9	0.439
	2023	148.8	754.2	0.440
	2024	149.0	755.7	0.441

	Year	Catch	Spawning Biomass	Depletion
Mgmt. Action: High Catch	2013	101.5	727.2	0.417
	2014	101.5	744.2	0.428
	2015	237.6	761.9	0.439
	2016	226.9	711.5	0.408
	2017	220.0	674.3	0.388
	2018	215.5	647.7	0.373
	2019	212.3	628.4	0.364
	2020	209.2	607.1	0.352
	2021	206.3	588.1	0.340
	2022	203.3	568.6	0.327
	2023	200.9	550.0	0.316
	2024	199.0	533.3	0.305

Table ES3. Decision table for China rockfish (north of 40° 10′ N lat.) base model. Alternative catch streams are median ABC catch projections (mt) with 40-10 adjustment based on quartiles of depletion in 2013. Median MSY is 9 mt/year.

	Year	Catch	Spawning Biomass	Depletion
Mgmt. Action: Avg. Catch 2010-2012	2013	15.2	84.1	0.367
	2014	15.2	81.7	0.356
	2015	15.2	79.0	0.344
	2016	15.2	76.8	0.334
	2017	15.2	74.6	0.323
	2018	15.2	72.0	0.312
	2019	15.2	70.0	0.302
	2020	15.2	67.9	0.291
	2021	15.2	65.5	0.280
	2022	15.2	63.1	0.269
	2023	15.2	60.6	0.258
	2024	15.2	58.2	0.246

	Year	Catch	Spawning Biomass	Depletion
Mgmt. Action: Low Catch	2013	15.2	84.1	0.367
	2014	15.2	81.7	0.356
	2015	1.3	79.0	0.344
	2016	1.6	83.8	0.365
	2017	1.8	87.8	0.383
	2018	2.0	91.1	0.398
	2019	2.1	94.7	0.410
	2020	2.2	97.3	0.420
	2021	2.2	100.4	0.432
	2022	2.3	103.0	0.445
	2023	2.5	105.8	0.457
	2024	2.6	108.4	0.468

	Year	Catch	Spawning Biomass	Depletion
Mgmt. Action: Median Catch	2013	15.2	84.1	0.367
	2014	15.2	81.7	0.356
	2015	6.1	79.0	0.344
	2016	6.5	81.3	0.354
	2017	6.7	83.1	0.362
	2018	6.9	84.2	0.368
	2019	7.0	85.7	0.372
	2020	7.0	86.5	0.374
	2021	7.1	87.5	0.376
	2022	7.2	88.4	0.380
	2023	7.2	89.4	0.382
	2024	7.3	90.0	0.386

	Year	Catch	Spawning Biomass	Depletion
Mgmt. Action: High Catch	2013	15.2	84.1	0.367
	2014	15.2	81.7	0.356
	2015	16.7	79.0	0.344
	2016	16.6	76.1	0.331
	2017	16.4	73.1	0.317
	2018	16.3	70.0	0.304
	2019	16.2	67.5	0.291
	2020	16.0	65.1	0.279
	2021	15.9	62.4	0.268
	2022	15.8	59.8	0.254
	2023	15.7	56.9	0.242
	2024	15.6	54.3	0.229

Table ES4. Decision table for China rockfish (south of 40° 10′ N lat.) base model. Alternative catch streams are median ABC catch projections (mt) with 40-10 adjustment based on quartiles of depletion in 2013. Median MSY is 32 mt/year.

Mgmt. Action	Year	Catch	Spawning Biomass	Depletion
Avg. Catch 2010-2012	2013	16.1	263.7	0.660
	2014	16.1	268.4	0.675
	2015	16.1	273.1	0.687
	2016	16.1	277.2	0.700
	2017	16.1	281.0	0.711
	2018	16.1	284.5	0.723
	2019	16.1	286.8	0.733
	2020	16.1	290.3	0.743
	2021	16.1	293.4	0.752
	2022	16.1	295.7	0.760
	2023	16.1	298.6	0.768
	2024	16.1	300.8	0.775

Mgmt. Action	Year	Catch	Spawning Biomass	Depletion
Low Catch	2013	16.1	263.7	0.660
	2014	16.1	268.4	0.675
	2015	33.7	273.1	0.687
	2016	33.0	268.4	0.678
	2017	32.5	264.3	0.670
	2018	32.2	260.7	0.665
	2019	31.9	256.7	0.660
	2020	31.7	254.1	0.656
	2021	31.5	252.2	0.653
	2022	31.3	250.4	0.649
	2023	31.1	248.6	0.647
	2024	31.0	247.5	0.644

Mgmt. Action	Year	Catch	Spawning Biomass	Depletion
Median Catch	2013	16.1	263.7	0.660
	2014	16.1	268.4	0.675
	2015	50.6	273.1	0.687
	2016	48.2	259.9	0.658
	2017	46.2	248.9	0.635
	2018	44.7	239.3	0.614
	2019	43.3	230.4	0.596
	2020	42.2	224.0	0.580
	2021	41.3	219.1	0.567
	2022	40.5	214.1	0.556
	2023	39.9	210.2	0.547
	2024	39.3	207.6	0.539

Mgmt. Action	Year	Catch	Spawning Biomass	Depletion
High Catch	2013	16.1	263.7	0.660
	2014	16.1	268.4	0.675
	2015	71.2	273.1	0.687
	2016	64.7	249.6	0.633
	2017	59.5	231.0	0.589
	2018	55.5	216.1	0.554
	2019	52.1	203.5	0.524
	2020	49.5	195.2	0.500
	2021	48.1	187.8	0.483
	2022	47.0	182.4	0.469
	2023	46.1	177.1	0.456
	2024	45.6	172.5	0.444

Table ES5. Decision table for copper rockfish (north of 34° 27′ N lat.) base model. Alternative catch streams are median ABC catch projections (mt) with 40-10 adjustment based on quartiles of depletion in 2013. Median MSY is 114 mt/year.

Mgmt. Action	Year	Catch	Spawning Biomass	Depletion
Avg. Catch 2010-2012	2013	38.3	794.8	0.476
	2014	38.3	821.0	0.492
	2015	38.3	845.6	0.507
	2016	38.3	871.7	0.523
	2017	38.3	897.1	0.540
	2018	38.3	922.6	0.556
	2019	38.3	948.2	0.571
	2020	38.3	973.4	0.586
	2021	38.3	997.6	0.601
	2022	38.3	1022.4	0.616
	2023	38.3	1044.8	0.630
	2024	38.3	1065.2	0.644

Mgmt. Action	Year	Catch	Spawning Biomass	Depletion
Low Catch	2013	38.3	794.8	0.476
	2014	38.3	821.0	0.492
	2015	72.6	845.6	0.507
	2016	73.1	854.5	0.513
	2017	74.0	864.1	0.520
	2018	75.0	874.4	0.527
	2019	76.0	885.6	0.535
	2020	77.2	898.0	0.542
	2021	78.4	909.2	0.549
	2022	79.4	920.2	0.556
	2023	80.2	930.6	0.562
	2024	80.9	938.2	0.568

Mgmt. Action	Year	Catch	Spawning Biomass	Depletion
Median Catch	2013	38.3	794.8	0.476
	2014	38.3	821.0	0.492
	2015	131.8	845.6	0.507
	2016	128.5	824.9	0.494
	2017	126.1	809.4	0.487
	2018	124.7	798.4	0.481
	2019	123.8	792.0	0.478
	2020	123.1	788.5	0.476
	2021	122.8	786.9	0.476
	2022	122.7	785.5	0.474
	2023	122.4	782.5	0.473
	2024	122.0	780.4	0.470

Mgmt. Action	Year	Catch	Spawning Biomass	Depletion
High Catch	2013	38.3	794.8	0.476
	2014	38.3	821.0	0.492
	2015	216.7	845.6	0.507
	2016	204.3	782.5	0.469
	2017	196.1	732.7	0.441
	2018	189.4	694.6	0.418
	2019	183.8	665.2	0.401
	2020	180.0	642.6	0.388
	2021	176.7	626.7	0.379
	2022	173.7	609.5	0.368
	2023	171.2	591.5	0.356
	2024	168.7	573.2	0.345

Table ES6. Decision table for copper rockfish (south of 34° 27′ N lat.). Alternative catch streams are median ABC catch projections (mt) with 40-10 adjustment based on quartiles of depletion in 2013. Median MSY is 84 mt/year.

	Year	Catch	Spawning Biomass	Depletion
Mgmt. Action: Avg. Catch 2010-2012	2013	39.6	698.6	0.762
	2014	39.6	705.0	0.772
	2015	39.6	710.0	0.781
	2016	39.6	714.2	0.789
	2017	39.6	717.4	0.797
	2018	39.6	720.5	0.804
	2019	39.6	724.2	0.810
	2020	39.6	728.1	0.814
	2021	39.6	730.9	0.819
	2022	39.6	734.8	0.824
	2023	39.6	738.7	0.828
	2024	39.6	741.6	0.832

	Year	Catch	Spawning Biomass	Depletion
Mgmt. Action: Low Catch	2013	39.6	698.6	0.762
	2014	39.6	705.0	0.772
	2015	89.7	710.0	0.781
	2016	87.3	689.2	0.764
	2017	85.5	670.6	0.749
	2018	84.0	655.1	0.735
	2019	83.0	643.1	0.723
	2020	82.0	631.9	0.711
	2021	81.5	622.6	0.701
	2022	80.8	615.6	0.694
	2023	80.1	610.7	0.689
	2024	79.5	606.9	0.686

	Year	Catch	Spawning Biomass	Depletion
Mgmt. Action: Median Catch	2013	39.6	698.6	0.762
	2014	39.6	705.0	0.772
	2015	152.0	710.0	0.781
	2016	141.5	658.0	0.730
	2017	133.2	615.8	0.688
	2018	126.7	581.1	0.652
	2019	121.4	554.3	0.621
	2020	117.1	532.9	0.595
	2021	113.6	515.9	0.576
	2022	111.3	504.0	0.564
	2023	109.6	493.4	0.555
	2024	108.0	484.9	0.548

	Year	Catch	Spawning Biomass	Depletion
Mgmt. Action: High Catch	2013	39.6	698.6	0.762
	2014	39.6	705.0	0.772
	2015	202.8	710.0	0.781
	2016	177.1	632.6	0.703
	2017	156.5	575.2	0.642
	2018	142.4	532.0	0.595
	2019	132.3	503.0	0.561
	2020	125.1	481.0	0.536
	2021	120.0	464.4	0.518
	2022	117.8	453.9	0.509
	2023	116.9	444.0	0.500
	2024	116.2	435.1	0.491

Shelf-slope stocks

Results for the shelf-slope fishery-independent stock assessments are provided in Tables ES7 through ES10. The average catch scenarios increase the stock biomass, and thus status, of all stocks in all states of nature relative to the other catch scenarios modeled. The high catch scenarios drop stock status below the target reference point in the base depletion state of nature by the end of the 12 year forecast for all four stocks. The rockfishes also drop below the limit reference point in the low depletion state of nature under the high catch scenario.

Table ES7. Decision table for sharpchin rockfish. Alternative catch streams are median ABC catch projections (mt) with 40-10 adjustment based on quartiles of depletion in 2013. "Spawning Biomass" is median female spawning stock biomass. "Depletion" is median depletion. Estimated MSY is 320 mt/year and the long-term average total yield based on $SPR_{50\%}$ is 270 mt/year.

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			State of nature					
			Low		Base		High	
Quantiles			0-0.25		0.25-0.75		0.75-1.0	
	Year	Catch	Spawning Biomass	Depletion	Spawning Biomass	Depletion	Spawning Biomass	Depletion
Low Catches	2015	195	3,485	51.5%	5,798	71.8%	7,904	86.3%
	2016	195	3,476	51.2%	5,791	71.6%	7,894	85.8%
	2017	194	3,469	50.9%	5,779	71.3%	7,881	85.4%
	2018	194	3,447	50.7%	5,762	71.1%	7,867	85.0%
	2019	193	3,440	50.4%	5,752	70.9%	7,852	84.8%
	2020	192	3,431	50.1%	5,743	70.6%	7,831	84.5%
	2021	191	3,426	49.9%	5,724	70.4%	7,798	84.2%
	2022	190	3,418	49.7%	5,705	70.2%	7,769	84.1%
	2023	189	3,401	49.5%	5,685	69.9%	7,744	83.8%
	2024	189	3,395	49.3%	5,667	69.8%	7,721	83.6%
Medium Catches	2015	382	3,371	51.1%	5,628	71.2%	7,561	86.0%
	2016	372	3,393	50.6%	5,531	69.5%	7,216	82.2%
	2017	363	3,394	50.1%	5,426	67.8%	6,908	78.4%
	2018	354	3,380	49.6%	5,300	66.1%	6,570	75.2%
	2019	347	3,377	49.2%	5,177	64.3%	6,313	72.5%
	2020	339	3,365	49.0%	5,091	62.7%	6,094	69.9%
	2021	334	3,363	48.6%	4,984	61.5%	5,895	67.5%
	2022	328	3,347	48.5%	4,933	60.4%	5,720	65.4%
	2023	322	3,321	48.3%	4,840	59.4%	5,561	63.8%
	2024	317	3,336	48.2%	4,770	58.5%	5,419	62.2%
High Catches	2015	750	3,343	50.6%	5,688	71.7%	7,863	86.0%
	2016	730	2,964	44.1%	5,338	66.4%	7,567	82.3%
	2017	703	2,594	38.6%	4,999	61.8%	7,310	87.7%
	2018	674	2,257	33.6%	4,643	57.2%	7,040	75.7%
	2019	650	1,953	28.9%	4,300	53.3%	6,791	73.1%
	2020	625	1,684	24.7%	4,001	49.6%	6,498	70.5%
	2021	612	1,392	20.8%	3,691	46.7%	6,215	68.6%
	2022	591	1,190	17.1%	3,479	43.6%	6,055	66.7%
	2023	575	980	13.9%	3,266	41.0%	5,935	65.0%
	2024	563	756	10.9%	3,095	38.6%	5,816	63.5%
Average Catches	2015	5	3,485	50.6%	5,664	72.0%	7,573	86.4%
	2016	5	3,602	51.9%	5,786	73.4%	7,643	87.4%
	2017	5	3,725	53.7%	5,895	74.7%	7,708	88.2%
	2018	5	3,826	54.9%	6,020	75.9%	7,768	89.0%
	2019	5	3,938	56.3%	6,121	77.0%	7,828	89.7%
	2020	5	4,042	57.7%	6,227	78.3%	7,888	90.3%
	2021	5	4,135	59.0%	6,327	79.3%	7,944	91.1%
	2022	5	4,260	60.4%	6,420	80.3%	7,998	91.6%
	2023	5	4,318	61.6%	6,510	81.2%	8,048	92.2%
	2024	5	4,418	62.6%	6,599	82.2%	8,096	92.8%

Table ES8. Decision table for yellowtail rockfish (north of 40° 10′ N lat.). Alternative catch streams are median ABC catch projections (mt) with 40-10 adjustment based on quartiles of depletion in 2013. “Spawning Biomass” is median female spawning stock biomass. “Depletion” is median depletion. Estimated MSY is 5728 mt/year and the long-term average total yield based on $SPR_{50\%}$ is 4805 mt/year.

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			State of nature					
			Low		Base		High	
Quantiles			0-0.25		0.25-0.75		0.75-1.0	
	Year	Catch	Spawning Biomass	Depletion	Spawning Biomass	Depletion	Spawning Biomass	Depletion
Low Catches	2015	3,936	43,502	52.8%	56,604	68.9%	62,979	83.4%
	2016	3,912	43,108	52.4%	56,063	68.3%	62,573	82.7%
	2017	3,879	42,738	52.0%	55,772	67.9%	62,187	81.9%
	2018	3,844	42,434	51.7%	55,468	67.4%	61,835	81.2%
	2019	3,818	42,206	51.3%	55,027	66.7%	61,524	80.6%
	2020	3,797	41,976	50.9%	54,624	66.4%	61,253	79.9%
	2021	3,777	41,749	50.6%	54,269	66.0%	61,019	79.6%
	2022	3,759	41,547	50.4%	53,958	65.7%	60,818	79.3%
	2023	3,744	41,393	50.1%	53,684	65.3%	60,644	79.0%
	2024	3,730	41,129	50.0%	53,444	64.9%	60,491	78.8%
Medium Catches		6,497	43,502	52.4%	54,304	69.3%	60,039	83.3%
	2016	6,312	43,252	52.1%	52,730	66.8%	55,750	87.0%
	2017	6,126	43,044	51.6%	51,060	64.6%	52,853	73.9%
	2018	5,962	42,955	51.1%	49,531	62.7%	50,294	70.5%
	2019	5,798	42,673	50.7%	48,227	61.0%	48,062	67.2%
	2020	5,638	42,597	50.4%	47,111	49.4%	46,136	64.4%
	2021	5,523	42,567	50.0%	46,260	58.2%	44,484	62.3%
	2022	5,417	42,547	49.9%	45,421	57.1%	43,067	60.5%
	2023	5,324	42,842	49.7%	44,594	56.2%	41,784	59.9%
	2024	5,251	42,899	49.4%	43,788	55.4%	40,810	57.6%
High Catches	2015	11,666	44,076	52.6%	54,174	69.4%	63,587	83.7%
	2016	11,148	39,125	46.6%	49,654	63.4%	60,602	78.9%
	2017	10,530	34,591	41.3%	45,256	58.0%	57,730	75.1%
	2018	10,032	30,672	36.4%	41,696	53.4%	55,222	71.7%
	2019	9,675	26,968	31.9%	38,467	49.6%	53,091	68.6%
	2020	9,333	23,925	28.2%	35,708	46.2%	51,319	66.1%
	2021	9,052	20,975	25.1%	33,481	43.0%	49,975	63.9%
	2022	8,830	18,205	22.3%	31,248	40.4%	48,657	62.2%
	2023	8,547	15,740	19.5%	29,253	38.2%	47,106	60.6%
	2024	8,311	13,900	17.0%	27,694	36.4%	46,200	59.3%
Average Catches	2015	1,376	45,023	52.7%	54,405	69.6%	61,190	83.7%
	2016	1,376	46,290	54.1%	55,352	70.7%	61,802	84.4%
	2017	1,376	47,532	55.4%	56,136	72.0%	62,370	84.9%
	2018	1,376	48,447	56.5%	56,980	72.9%	62,899	85.5%
	2019	1,376	49,334	57.7%	57,758	73.7%	63,390	86.1%
	2020	1,376	50,528	59.0%	58,506	74.6%	63,845	86.5%
	2021	1,376	51,821	59.9%	59,109	75.5%	64,267	86.9%
	2022	1,376	52,752	61.0%	59,675	76.2%	64,658	87.3%
	2023	1,376	53,532	62.1%	60,139	77.0%	65,020	87.6%
	2024	1,376	54,297	63.1%	60,643	77.7%	65,355	87.9%

Table ES9. Decision table for English sole. Alternative catch streams are median ABC catch projections (mt) with 40-10 adjustment based on quartiles of depletion in 2013. “Spawning Biomass” is median female spawning stock biomass. “Depletion” is median depletion. Estimated MSY is 4072 mt/year and the long-term average total yield based on $SPR_{25\%}$ is 3875 mt/year.

			State of nature					
			Low		Base		High	
Quantiles			0-0.25		0.25-0.75		0.75-1.0	
	Year	Catch	Spawning Biomass	Depletion	Spawning Biomass	Depletion	Spawning Biomass	Depletion
Low Catches	2015	8,909	33,061	86.2%	24,798	90.7%	24,306	94.0%
	2016	7,247	26,491	67.9%	18,414	67.2%	18,274	71.1%
	2017	6,146	21,871	56.6%	14,277	52.0%	14,593	56.8%
	2018	5,379	18,728	48.7%	11,709	42.6%	12,608	48.6%
	2019	4,858	16,631	43.3%	10,061	37.1%	11,880	44.2%
	2020	4,529	15,286	39.7%	9,293	34.0%	11,515	43.0%
	2021	4,305	14,401	97.2%	8,908	32.3%	11,386	42.1%
	2022	4,151	13,766	35.5%	8,606	31.3%	11,128	41.4%
	2023	4,018	13,279	34.3%	8,424	30.7%	11,077	41.8%
	2024	3,939	12,947	33.4%	8,319	30.2%	10,982	42.0%
Medium Catches	2015	9,452	33,131	86.2%	24,735	90.7%	24,844	94.1%
	2016	4,098	26,338	67.7%	18,131	65.7%	16,751	63.2%
	2017	5,733	61,662	55.5%	14,115	50.8%	12,720	47.3%
	2018	4,972	18,441	47.3%	11,791	42.4%	10,602	39.6%
	2019	4,574	16,343	42.0%	10,538	37.9%	9,587	36.0%
	2020	4,332	14,991	38.6%	9,810	65.4%	9,065	34.3%
	2021	4,184	41,092	36.4%	9,401	34.0%	8,727	33.2%
	2022	4,073	13,465	34.8%	9,096	33.1%	8,490	32.6%
	2023	3,992	13,008	33.7%	8,916	32.4%	8,428	32.1%
	2024	3,922	12,662	33.0%	8,768	31.9%	8,340	31.7%
High Catches	2015	11,901	32,854	86.3%	25,220	90.6%	25,473	94.1%
	2016	2,368	23,791	61.8%	16,600	59.1%	17,158	63.6%
	2017	6,790	23,311	60.9%	16,346	58.2%	17,307	63.7%
	2018	5,975	19,630	51.5%	13,092	46.5%	14,308	53.7%
	2019	5,691	16,975	44.7%	10,874	38.8%	12,784	47.7%
	2020	5,446	14,926	39.1%	9,324	33.2%	11,642	43.0%
	2021	5,258	13,185	34.9%	8,098	29.1%	10,594	40.1%
	2022	5,106	12,087	31.5%	7,196	26.3%	10,178	38.2%
	2023	5,007	11,004	28.6%	6,557	24.3%	9,903	36.7%
	2024	4,960	10,260	26.4%	6,114	22.6%	9,600	36.2%
Average Catches	2015	224	33,061	85.9%	25,473	90.7%	25,687	94.0%
	2016	224	33,694	87.3%	24,996	91.8%	25,853	94.6%
	2017	224	34,117	88.5%	25,186	92.6%	25,981	95.1%
	2018	224	34,518	89.6%	25,377	93.3%	26,078	95.4%
	2019	224	34,916	90.6%	25,522	93.8%	26,153	95.7%
	2020	224	35,358	91.4%	25,635	94.3%	26,210	96.0%
	2021	224	35,746	92.1%	25,725	94.6%	26,253	96.0%
	2022	224	36,087	82.6%	25,798	94.9%	26,286	96.3%
	2023	224	36,387	93.2%	25,857	95.1%	26,312	96.4%
	2024	224	36,651	93.6%	25,904	95.3%	26,332	96.6%

Table ES10. Decision table for rex sole. Alternative catch streams are median ABC catch projections (mt) with 40-10 adjustment based on quartiles of depletion in 2013. "Spawning Biomass" is median female spawning stock biomass. "Depletion" is median depletion. Estimated MSY is 1676 mt/year and the long-term average total yield based on $SPR_{25\%}$ is 1646 mt/year.

			State of nature					
			Low		Base		High	
Quantiles			0-0.25		0.25-0.75		0.75-1.0	
	Year	Catch	Spawning Biomass	Depletion	Spawning Biomass	Depletion	Spawning Biomass	Depletion
Low Catches	2015	3,085	3,772	72.9%	3,377	80.7%	4,396	89.7%
	2016	2,541	3,113	59.4%	2,837	68.8%	3,989	81.4%
	2017	2,174	2,568	50.6%	2,490	60.8%	3,742	76.1%
	2018	1,909	2,237	44.8%	2,262	55.7%	3,560	72.9%
	2019	1,753	2,102	41.1%	2,137	52.6%	3,448	71.0%
	2020	1,652	2,022	38.7%	2,031	50.6%	3,380	70.3%
	2021	1,590	1,970	36.9%	1,986	49.3%	3,339	69.7%
	2022	1,544	1,928	35.8%	1,939	48.5%	3,313	69.4%
	2023	1,510	1,887	35.2%	1,924	48.1%	3,297	69.2%
	2024	1,485	1,857	34.6%	1,917	47.9%	3,287	69.1%
Medium Catches	2015	4,395	3,788	73.4%	3,073	81.1%	4,076	89.5%
	2016	3,342	3,023	59.5%	2,382	62.0%	2,937	64.7%
	2017	2,701	2,569	50.4%	1,938	50.3%	2,313	50.7%
	2018	2,308	2,279	44.3%	1,662	43.4%	1,963	43.3%
	2019	2,067	2,086	40.5%	1,511	39.4%	1,765	39.2%
	2020	1,926	1,940	38.1%	1,421	37.1%	1,663	36.9%
	2021	1,839	1,859	36.5%	1,371	35.7%	1,602	35.7%
	2022	1,778	1,812	35.6%	1,335	34.8%	1,562	34.9%
	2023	1,738	1,784	34.9%	1,305	34.2%	1,517	34.3%
	2024	1,711	1,764	34.4%	1,283	33.8%	1,496	33.8%
High Catches	2015	7,895	3,720	73.4%	3,073	81.1%	4,093	89.5%
	2016	5,315	1,684	34.1%	1,717	44.9%	2,866	64.7%
	2017	4,116	928	20.3%	973	27.4%	2,208	51.6%
	2018	3,382	732	15.8%	731	21.0%	1,927	44.8%
	2019	1,947	685	14.0%	655	18.9%	1,726	41.2%
	2020	2,722	657	13.6%	641	18.7%	1,791	42.3%
	2021	2,547	629	13.1%	605	17.5%	1,697	40.7%
	2022	2,470	607	12.4%	571	16.4%	1,663	40.0%
	2023	2,387	594	11.9%	552	15.6%	1,612	39.5%
	2024	2,344	578	11.6%	542	15.2%	1,579	38.9%
Average Catches	2015	455	3,687	73.2%	3,158	81.0%	3,686	89.9%
	2016	455	3,761	74.4%	3,191	81.9%	3,707	90.3%
	2017	455	3,824	75.4%	3,220	82.6%	3,723	90.6%
	2018	455	3,874	76.3%	3,245	83.2%	3,737	90.9%
	2019	455	3,919	77.2%	3,266	83.7%	3,747	91.1%
	2020	455	3,959	77.9%	3,285	84.2%	3,757	91.3%
	2021	455	3,993	78.4%	3,301	84.6%	3,765	91.6%
	2022	455	4,022	78.9%	3,315	84.9%	3,771	91.7%
	2023	455	4,047	79.4%	330	85.2%	3,777	91.9%
	2024	455	4,067	79.8%	3,340	85.5%	3,782	92.0%

1 Introduction

The following work applies new data-moderate stock assessment methods to nine west coast groundfishes: brown rockfish (*Sebastes auriculatus*), China rockfish (*Sebastes nebulosus*), copper rockfish (*Sebastes caurinus*), sharpchin rockfish (*Sebastes zacentrus*), stripetail rockfish (*Sebastes saxicola*), yellowtail rockfish (*Sebastes flavidus*); English sole (*Parophrys vetulus*), rex sole (*Glyptocephalus zachirus*). Two of the species (English sole and yellowtail rockfish) have previous Council-approved, but currently outdated, assessments. The remaining species previously only had category 3 (catch-only) assessment estimates of OFL.

There was insufficient time during the review to evaluate all the assessments originally requested by the Council. Assessments for vermilion/sunset rockfishes (*Sebastes miniatus* and *Sebastes crocotulus*) and yellowtail rockfish (south of 40° 10′ N lat.) were not presented by the Stock Assessment Team (STAT).

1.1 Biology, Ecology, and Life History

The following are brief descriptions of pertinent biological and ecological considerations for each stock presented by ecological and taxonomic groups.

1.1.1 Nearshore rockfishes

The following three species are currently managed in the nearshore rockfish stock complexes:

<u>Brown rockfish</u> (*Sebastes auriculatus*) is a medium-sized, commercially (mainly in the live-fish fishery) and recreationally important nearshore rockfish ranging from Baja Mexico to southeast Alaska, though core abundance within PFMC-managed waters is south of Cape Mendocino. Brown rockfish are associated with rocky reefs and show distinct genetic differentiation by distance in coastal populations off California (Buonaccorsi et al. 2005), though no distinct break is obvious to define substocks. Life history information is not spatially resolved. While coastwide populations may be subject to localized depletion because of reef-specific associations and small home ranges, no subpopulations have been distinguished. Brown rockfish is therefore initially explored as one coastwide population for the purpose of this assessment. Brown rockfish has a notably elevated vulnerability to overfishing (V = 1.99; Cope et al. 2011) and is listed on NOAA's Fishery Stock Sustainability Index (FSSI). Brown rockfish have been aged to 34 years (Love et. al 2002; Table 1). No stock assessment has previously been conducted for brown rockfish.

<u>China rockfish</u> (*Sebastes nebulosus*) is a medium-sized, commercially (mainly in the live-fish fishery) and recreationally prized deeper-dwelling nearshore rockfish ranging from southern California, north to the Gulf of Alaska. Core abundance is found from northern California to southern British Columbia, Canada. Individuals tend to be solitary and usually found in rock habitats. Limited information is available on stock structure or life history, though additional considerations are given in the modeling section for separate stocks north and south of Cape Mendocino. China rockfish have been aged to almost 80 years old (Table 1), one the oldest aged rockfishes with common occurrences deeper than 100m. China rockfish vulnerability to overfishing is one of the highest recorded (V = 2.23) for west coast groundfishes. No stock assessment has previously been conducted for China rockfish. China rockfish is not listed on the FSSI.

<u>Copper rockfish</u> (*Sebastes caurinus*) is a medium- to large-sized nearshore rockfish found from Mexico to Alaska. The core range is comparatively large, from northern Baja Mexico to the Gulf

of Alaska, as well as in Puget Sound. They occur mostly on low relief or sand-rock interfaces. Copper rockfish have historically been a part of both commercial (mainly in the live-fish fishery) and recreational fisheries throughout its range. Genetic work has revealed significant differences between Puget Sound and coastal stocks, but not among the coastal stocks (Buonaccorsi et al. 2002). Though genetic or ecological evidence is lacking for defining population structure, model fit considerations are described in the model results section that support stock distinction north and south of Point Conception. Copper rockfish live at least 50 years (Table 1) and have the highest vulnerability (V=2.27) of any west coast groundfish. No stock assessment has previously been conducted for copper rockfish. Copper rockfish is not listed on the FSSI.

Alternative (state border) stock boundaries for the nearshore rockfishes were explored after the STAR panel. Without information to support either alternative, the SSC ultimately recommended use of stock boundaries that are consistent with PFMC management areas, i.e., split at 40° 10′ N Lat., near Cape Mendocino (PFMC, 2014).

1.1.2 Shelf and Slope Rockfishes

The following three species have been managed in either the slope rockfish stock complexes (sharpchin and stripetail rockfish), the southern Shelf Rockfish complex (yellowtail rockfish south of 40°10’ N lat.), or with a species-specific quota (yellowtail rockfish north of 40°10’ N lat.).

Sharpchin rockfish (*Sebastes zacentrus*) is a smaller-sized rockfish that inhabits waters up to 500 m, typically over muddy-rock habitats and range from Southern California to Alaska, though core range is northern California to Alaska in waters up to 300 m (Figure 1 and Figure 2). Sharpchin are not a major commercial target, though they are taken in large numbers and commonly seen in trawls that target Pacific ocean perch (POP; *Sebastes alutus*). They are not a major component of any recreational fisheries. There is no indication of population structure in sharpchin rockfish, so one coastwide stock is assumed for assessment purposes. Sharpchin rockfishes live to at least 58 years (Table 1) and have high vulnerability (V = 2.05) to overfishing. No stock assessment has previously been conducted for sharpchin rockfish. Sharpchin rockfish is not listed on the FSSI.

Stripetail rockfish (*Sebastes saxicola*) is a smaller-sized rockfish differing from sharpchin in that its range is more southerly (Mexico to Alaska, but mostly from southern California to British Columbia) and core depths a bit shallower (down to 200 m; Figure 3 and Figure 4). They tend to be found on sandy-rock bottoms in high numbers, co-occurring with the ubiquitous greenstriped rockfish (Cope and Haltuch 2012). Though found in trawl fisheries, they are neither a target of commercial or recreational fisheries. They also are not as long-lived (at least 38 years old; Table 1) as sharpchin, thus are considered only moderately vulnerable to overfishing (V = 1.80). No stock assessment has previously been conducted for stripetail rockfish. Stripetail rockfish is not listed on the FSSI.

Yellowtail rockfish (*Sebastes flavidus*) is a mid-water to high-relief dwelling rockfish distributed from northern California to the Aleutian Islands. Core distribution is central California to Alaska (Figure 5 and Figure 6). Yellowtail rockfish are common in both commercial and recreational fisheries throughout its range and commonly occur with canary and widow rockfishes (Cope and Haltuch 2012). Despite historically large removals and its popularity in commercial and recreational fisheries, its association with those highly regulated species has greatly decreased removals over the last decade. Due to this low susceptibility to fisheries removals, the vulnerability to overfishing of yellowtail rockfish is relatively low (V = 1.88), though the productivity of this species is also relatively low, including a longevity to almost 70 years (Table 1). A previous assessment conducted for yellowtail rockfish (Wallace and Lai 2004) separated stocks at Cape Mendocino and with only the northern stock assessed. That stock was estimated to be above the relative spawning biomass reference point of 40% of unfished levels. Hess et al. (2011) described a strong break in the genetic structure of yellowtail rockfish at Cape Mendocino, supporting the stock structure assumed in the previous assessment. That same structure is maintained in this assessment, with the southern stock having no prior assessment. Due to time constraints on model development and review, the attempt at assessing the southern stock of yellowtail is not included in this document, thus results are only presented for yellowtail north. Yellowtail rockfish is listed on the FSSI.

1.1.3 Flatfishes

English sole (*Parophrys vetulus*) is a medium-sized wide ranging and common flatfish species from Baja California to Alaska (Figure 7 and Figure 8). English sole are most common in depths less than 200 m, though they can be found down to 550 m. English sole have a long history of commercial removals, almost exclusively in trawl fisheries, with records dating back into the late 1800s. Peaks in catches occurred post-World War II, but catches were relatively high from 1920-1980. Since then, catches have significantly declined and are currently at historic lows. This landings history, coupled with fairly high productivity and relatively low maximum ages (20+ years old; Table 1), determines a vulnerability to overfishing as one of the lowest of the groundfishes (V = 1.19). The English sole stock was last assessed in 2007 and found to be well above the initial spawning biomass estimate and was at or above the target biomass since 2000. English sole is listed on the FSSI.

Rex sole (*Glyptocephalus zachirus*) is a medium sized, moderately long-lived (up to almost 30 years; Table 1) right-eyed flatfish ranging widely in distribution from central Baja California to the Aleutian Islands (Figure 9 and Figure 10). They are common in a large part of their recorded range, from southern California to the Aleutian Islands. They are also distributed in deeper depths, commonly found in waters up to at least 500 m and range down to more than 1100 m. Rex sole are commonly caught in fishery-independent trawl surveys and trawl fisheries. Targeting for rex sole in commercial fisheries has varied over the years, with major removals occurring in the mid-20th century to provide feed for mink farms. They have not been targeted heavily in the last few decades, thus their vulnerability to overfishing is believed to be low (V = 1.28). Rex sole is listed on the FSSI and does not have a previously conducted stock assessment.

2 Assessment

2.1 Data and Inputs

2.1.1 Removal histories

Annual estimates of commercial and recreational landings by species, year, and coastal region were compiled for each species. Catches from U.S. waters were partitioned into three regions, divided at Point Conception and Cape Mendocino which are widely recognized as major biogeographic boundaries along the US west coast (Figure 11): “Southern” (US-Mexico border to Point Conception), “Central” (Point Conception to Cape Mendocino), and “Northern” (Cape Mendocino to the US-Canada border). The Northern region is equivalent to the Eureka, Columbia, and Vancouver INPFC areas. The Southern and Central regions are divided at Point Conception (34° 27’ N lat.), rather than the northern boundary of the INPFC “Conception” area (36° N lat.).

Catch data were compiled from a variety of sources (Table 2). Notable gaps in the catch reconstructions are recreational removals prior to 1980 in Oregon and prior to 1967 in Washington. In terms of total cumulative landings and discard, the species rank (in descending order) are as follows: English sole, yellowtail rockfish, rex sole, sharpchin rockfish, copper rockfish, brown rockfish, stripetail rockfish, and China rockfish.

2.1.2 Catch data sources

2.1.2.1 PacFIN

The primary source for commercial landings data between Cape Mendocino and the US-Canadian border was the Pacific Fisheries Information Network (PacFIN, pacfin.psmfc.org). We queried PacFIN using INPFC-based area stratification to obtain groundfish landings from 1981-2012. Landings reported from "nominal" market categories were pooled with corresponding categories.

2.1.2.2 CALCOM

The CALCOM database was the source for California's commercial landings estimates for the area south of Cape Mendocino from 1969-2012, and the area between Cape Mendocino and the CA-OR border from 1969-1980. Since multiple species are often landed within a single market category, it is necessary to "expand" landings estimates from fish tickets using species composition data obtained by port samplers. CALCOM is the source of these "expanded" landings for California, and generates estimates of species compositions and catch by year, quarter, market category, gear group, port complex, and fishery condition (i.e., live / non-live). Expanded species compositions are uploaded to PacFIN on a monthly basis, where they are applied to landings by market category from fish ticket data. A final "annual expansion" is uploaded to PacFIN when all landing receipts for a given year have been submitted. Pearson et al. (2008) describe the reliability of commercial groundfish landings in California from 1969-2006.

2.1.2.3 RecFIN

Annual estimates of total recreational catch (landings and discard) for California and Oregon were obtained from the Recreational Fisheries Information Network website (RecFIN; www.recfin.org) for the period 1980-2011. Estimates for 2012 were provided by the states' Groundfish Management Team representatives. For these states, total recreational catch was assumed equal to the combined weight of catch types A and B1 (sampler-examined landed catch, and angler-reported discards). Sampling for RecFIN did not occur from 1990-1992 due to lack of funding. Northern California party boat data from 1993-1995 are also not available from RecFIN. We estimated total recreational catch by state and species for the years 1990-1992 using a linear interpolation. Prior to 2004, recreational catch between Cape Mendocino and the CA-OR border was estimated by calculating the percentage of A+B1 catch in CRFS District 6 relative to A+B1 catch in CRFS Districts 3 through 6 from 2004-2011. The percentages were 1%, 7%, and 6.5% for brown rockfish, China rockfish, and copper rockfish, respectively.

2.1.2.4 NORPAC

Estimated bycatch of groundfish species from the at-sea whiting fleet is available for the years 1991-2012 from the NORPAC database. We queried NORPAC data (accessible through PacFIN) for estimates of total bycatch weight by species, area, and year. Annual estimates of total bycatch by species from this fishery were included in our catch reconstructions without modification.

2.1.2.5 Foreign fleets (Rogers 2003)

Foreign fleets caught substantial amounts of groundfish off the west coast of the United States in 1965-1976. Rogers (2003) described these fisheries in detail and developed a standardized method for estimating rockfish catch during this time period by nation, area, and year. We include Rogers' catch estimates in our analysis without modification

2.1.2.6 California Historical Catch Reconstructions (Commercial and Recreational)

Ralston et al. (2010) describe a reconstruction of California's commercial landings prior to 1969 and recreational landings prior to 1981. We queried the database maintained by the SWFSC Fisheries Ecology Division for commercial groundfish landings from 1916-1969 and recreational rockfish catch (landings + discard) from 1928-1980.

2.1.2.7 Oregon Commercial Catch Reconstructions

Historical landings from Oregon's commercial fisheries were provided by V. Gertseva (NMFS, pers. comm.). Landings estimates were stratified by year, species, and gear (trawl vs. non-trawl), but gear types were aggregated for this analysis.

2.1.2.8 English sole stock assessment (Stewart 2007)

Estimates of total catch (landings plus discard) of English sole were taken from the 2007 stock assessment, which estimated discards within the assessment model (Stock Synthesis).

2.1.2.9 WA commercial trawl records (Tagart 1985)

Estimates of trawl-caught rockfish in Washington by year, species, PMFC area, and reporting agency (CDFG, ODFW, WDFW, and DFO Canada) for the years 1963-1980 were obtained from Tagart (1985). We calculated species compositions from the 1969-1976 data (prior to the development of the widow rockfish fishery) and applied them to Tagart's aggregated rockfish landings from 1963-1968.

2.1.2.10 Pacific Marine Fisheries Commission (PMFC) Data Series, 1956-1980

The Pacific Marine Fisheries Commission (PMFC; now known as Pacific States Marine Fisheries Commission) compiled commercial catch statistics by market category, year, month, area, and agency beginning in 1956. Landings estimates were limited to trawl gear prior to 1971 (Lynde, 1986). These data are commonly referred to as the "Data Series" and were digitized and made available by the Northwest Fisheries Science Center (NWFSC) of the National Marine Fisheries Service (NMFS). Landings in the Data Series are stratified by area where caught, as opposed to landing location. The Data Series is described in detail by Lynde (1986).

2.1.2.11 Pacific Fisherman Yearbooks

Pacific Fisherman yearbooks provide a record of total rockfish landings in Washington from the 1930s to 1956 (Anonymous, 1947, 1957; as cited in Stewart, 2007). Reported rockfish catch is partitioned into POP and other rockfish categories after 1952. Stewart (2007) found this source to be similar to catch reported in the Current Fishery Statistics series published by the Fish and Wildlife Service (see multiple citations in Stewart, 2007), with the exception of one year (1945) in which the Pacific Fisherman data estimated 7,300 mt and the Fish and Wildlife Service data showed 11,552 mt of total rockfish landings. We retained the estimate from the Pacific Fisherman yearbooks to maintain consistency with the remainder of the time series. The Pacific Fisherman data include landings originating from Canadian waters. To estimate yield available from U.S. stocks (assuming they are independent) it is necessary to identify the fraction of catch originating in U.S. waters. Alverson (1957) reports the fraction of landed rockfish that originated from U.S. waters during 1953 (14.9% for other rockfish and 9.7% for POP). We applied these proportions to the Pacific Fisherman landings to get Washington landings from U.S. waters. For years reporting only total rockfish, we used the average proportion. We then applied the 1969-1976 species composition data from Tagart (1985) to our estimates of total rockfish caught in U.S. waters off Washington to estimate rockfish landings by species from 1942-1955, as these composition data are the best available information at this time. As with the PFMC Data Series, this application of the Tagart composition data makes a strong assumption that rockfish species compositions do not vary over time. In summary, estimates of total rockfish landings in

Washington for years prior to 1981 are derived from 4 sources: Pacific Fisherman yearbooks, PMFC Data Series Reports, Alverson (1957), and Tagart (1985).

2.1.2.12 Wallace and Lai (2005)

Landings of yellowtail rockfish north of Cape Mendocino (1967-2004) were estimated in the 2005 stock assessment (Wallace and Lai, 2005). The authors also obtained estimates of yellowtail caught in US waters but landed in Canada. These foreign landings were added to the recently reconstructed landings for yellowtail rockfish.

2.1.2.13 CDFG Fish Bulletin #74

Landings of rex sole from 1916-1930 were reconstructed from total sole landings reported in CDFG Fish Bulletin 74 (1949). The Bulletin reports 5.1% as the approximate proportion of rex sole in total sole landings observed in 1947, and this percentage was assumed constant for the years 1916-1930.

2.1.2.14 Washington Recreational Removals

Washington Department of Fish and Wildlife (Tsou, pers. comm.) supplied total numbers of recreationally-landed and released fishes in coastal waters from 1975-2012, 3 of which are rockfishes being considered in these assessments (China, copper, and yellowtail rockfishes). The years 1987-1989 were missing, so stock-specific linear interpolation of landings were made using 1986 and 1990 landings as endpoints. The number of fish released was not recorded prior to 2002. The years 1995-2002 had the same rockfish bag limits, so the ratio of released to landed fish in 2002 was multiplied by the landing in years 1995-2001. No information on releases are available for the years 1975-1994 when no bag limits were in effect, so a value of 0.5 times the 2002 release ratio was assumed. There was an isolated report of landings in 1967 (Buckley et al. 1967). Missing years from 1975-1960 (1960 catch was assumed to be 0) were therefore interpolated through the 1967 value, with discards assumed as in the years 1975-1994. Finally, no information on mortality of released fishes was available, so the bracketing scenarios of 0% and 100% mortality were assumed, with the latter chosen as the base case and the former as a sensitivity run.

Removals were recorded as numbers of fish, but biomass is preferred in the assessment models. Length compositions of catch from 1997-2012 were converted to weight compositions using length-weight relationships (Table 1). Weights were then averaged over all years. Each year of assumed numbers removed was then multiplied by the average weight to get the final removals in metric tons.

2.1.2.15 Discard Estimates

Discard from recreational fisheries (apart from WA, described above) was included in the downloaded RecFIN estimates (catch type A+B1) and the CA recreational catch reconstruction (Ralston et al. 2010).

Following Dick and MacCall (2010), discard ratios (discard/retained) for commercial fisheries were calculated from WCGOP annual reports (NWFSC, 2008, 2009; their Table 3a) as the ratio of discarded catch in 2008-2009 to retained catch in 2008-2009. When species-specific rates were not available, estimates were derived from aggregated categories (e.g., shelf rockfish). Data from Pikitch et al. (1988) were used to develop point estimates of discard in 1986 for rex sole and sharpchin rockfish, with years in between estimated using linear interpolation to the NWFSC values. Historical discard ratios were assumed to be equal to the earliest available source of discard information for that species. The estimated discard rates were constant over all years for brown, China, copper, and stripetail rockfishes (11%, 13%, 13%, and 44%, respectively). Harry

(1956) observed nearly 100% discard of rex sole in the Oregon otter trawl fishery around 1950. In California, rex sole ranked third (slightly over 5%) among sole species in the 1947 trawler catch (CDFG Fish Bulletin No. 74). Historical discard rates are therefore a source of uncertainty in removals, and appear to vary by region. For the base model, we assume a 1:1 ratio of discard to retained fish for rex sole in years prior to 1950. Total removals for English sole (including discards) were taken from the 2007 update assessment, with an assumed discard rate of 33% for years after 2006 (based on WCGOP annual reports). Time-varying estimates of discard rates for rex sole, sharpchin rockfish, and yellowtail rockfish (north of Cape Mendocino) are shown in Figure 12.

2.1.3 Species removals by fishery, region, and data source

2.1.3.1 Brown rockfish

Coastwide, recreational fishing has accounted for approximately 56% of cumulative historical removals for brown rockfish (44% commercial). The percentages of total catch in the northern, central, and southern regions are 1%, 80%, and 18%, respectively (Table 3 and Table 4; Figure 13).

2.1.3.2 China rockfish

Coastwide, recreational fishing has accounted for approximately 64% of cumulative historical removals for China rockfish (36% commercial). The percentages of total catch in the northern, central, and southern regions are 21%, 73%, and 5%, respectively (Table 5 and Table 6; Figure 14)

2.1.3.3 Copper rockfish

Coastwide, recreational fishing has accounted for approximately 86% of cumulative historical removals for copper rockfish (14% commercial). The percentages of total catch in the northern, central, and southern regions are 4%, 63%, and 33%, respectively (Table 7 and Table 8; Figure 15).

2.1.3.4 Sharpchin rockfish

Landings of sharpchin rockfish are almost entirely from commercial sources (negligible recreational landings relative to commercial landings). The percentages of total catch in the northern, central, and southern regions are 97%, 3%, and 0%, respectively (Table 9 and Table 10; Figure 16).

2.1.3.5 Stripetail rockfish

Landings of stripetail rockfish are almost entirely from commercial sources (negligible recreational landings relative to commercial landings). The percentages of total catch in the northern, central, and southern regions are 60%, 40%, and 0%, respectively (Table 11 and Table 12; Figure 17).

2.1.3.6 Yellowtail rockfish

Coastwide, recreational fishing has accounted for approximately 5% of cumulative historical removals for yellowtail rockfish (95% commercial). The percentages of total catch in the northern, central, and southern regions are 84%, 15%, and 1%, respectively (Table 13 and Table 14; Figure 18). A linear ramp in catch was assumed from 0 mt in 1900 to 529 mt in 1916.

2.1.3.7 English sole

Landings of English sole are almost entirely from commercial sources (negligible recreational landings relative to commercial landings). Model-estimated discards from the 2007 assessment were not reported by our regional definitions, so we illustrate the relative magnitude of landings by region based on an assumed constant 33% discard rate. The percentages of total catch in the northern and combined central/southern regions are 50% and 50%, respectively (Figure 19). This assessment uses the same coastwide removals (including discard) as the 2007 assessment (Stewart, 2007), with PacFIN and CALCOM estimates for years after 2006 and an assumed 33% discard rate (Table 15 and Table 16).

2.1.3.8 Rex sole

Landings of rex sole are almost entirely from commercial sources (negligible recreational landings relative to commercial landings). The percentages of total catch in the northern, central, and southern regions are 69%, 30%, and <1%, respectively (Table 17 and Table 18; Figure 20).

2.1.4 Fishery-independent surveys

2.1.4.1 Survey types

There are two main fishery-independent trawl surveys used in most west coast groundfish assessments (Table 19): 1) The Alaska Fisheries Science Center (AFSC) Triennial shelf survey (1977-2004) and the annual Northwest Fisheries Science Center (NWFSC) shelf-slope trawl survey (2003-present). Though each survey uses trawl gear to sample groundfishes, the gear specifications, latitudinal and depth distributions, and survey design differs (Cope and Haltuch 2012).

The latitudinal distributions of the Triennial Surveys are shown in Table 20. The dataset has been trimmed to exclude tows taken south of Pt. Conception (ca. 34.5º N lat.) and in Canada (ca. 48.5º N lat.). The southernmost latitude bin was not sampled in 1980, 1983, and 1986. The depth distributions of the Triennial Surveys are shown in (Table 21). The 1977 survey did not sample depths shallower than 95 m, and the 1980-1992 surveys did not sample depths greater than about 350 m. The temporal distributions of the Triennial Surveys are shown in Table 22. Beginning in 1995, surveys began and ended about 5 weeks earlier than previous surveys.

The Triennial survey used setline transects with randomly placed trawls as the survey was conducted. In addition, changes in timing and coverage of the triennial survey pre- and post-1995 have made it common practice to break that survey into two time periods. We have used this approach in these assessments as well, resulting in two separate indices for the Triennial survey: Triennial-early including 1980-1992; and Triennial-late including 1995-2004. The first year of the triennial survey (1977) has also typically been dropped because of differences in depth coverage (i.e., shallower depths were excluded) versus other years in the survey. All water hauls and foreign catch are traditionally removed from these datasets. Base case models assume these common practices in subsequent data preparation and development of abundance indices.

In general, the NWFSC shelf-slope survey (also referred to as the combo survey) has surveyed deeper waters with greater latitudinal range, and employs a stratified random design rather than setline transects with randomly placed trawls as the triennial survey was conducted.

A third survey, the AFSC slope survey (1997-2001) was also considered, but either the frequency of occurrence of most species was too low or resultant indices were deemed insufficiently informative (see explanation below). Therefore, all subsequent results are reported for only the AFSC triennial and NWFSC annual shelf-slope surveys.

2.1.4.2 GLMM analysis

Delta-Generalized Linear Mixed Models (delta-GLMMs) were used rather than assuming design-based expanded swept-area estimates of abundance. Delta-GLMMs are preferred because they model both probability of positives and the magnitude of positive tows and allow for different factors such as vessel and strata effects to be considered in a holistic modeling environment that propagates the uncertainty through all considered processes. An updated Bayesian implementation of this approach was used (Thorson and Ward in press). Lognormal and gamma errors structures were considered for the positive tows, including the option to model extreme catch events (ECEs), defined as hauls with extraordinarily large catches, as a mixture distribution (Thorson et al. 2011). There were therefore four total positive tow error structures considered: gamma or lognormal with or without ECEs mixture distributions. Model convergence was evaluated using the effective sample size of all estimated parameters (typically >500 of more than 1000 kept samples would indicate convergence), while model goodness-of-fit was evaluated using Bayesian Q-Q plots. The resultant coefficients of variation (CVs) of each model were also considered when determining viable indices (i.e., CVs consistently >2 in each year were deemed uninformative and not used). Much discussion was given to the appropriate way to select among model error and whether or not to model extreme catch events. The STAR panel felt there was insufficient information to select the ECE models, so they were not considered in final model selection. Deviance was ultimately used to choose between the lognormal and gamma, though more research into improved model selection criteria for these GLMM models is needed.

Stratification for each survey was determined by considering first the design-based strata, then any additional strata that give at least 5 positive occurrences for each stratum. Design strata can be broken up into finer strata, but combining strata of differential sampling effort could create bias, thus combining strata was limited to cases where additional samples could be added with small increases in depth beyond a certain strata boundary. Design depth strata considered were 55-183 m,183-366 m, and 366-500m; and 55-183 m, 183-549m, and 549-1280m for the AFCS triennial and NWFSC annual surveys, respectively. There were no specific latitudinal design strata for the AFSC triennial survey, but the NWFSC had one latitudinal effort break at 34.5º N lat. (near Pt. Conception). Only five stocks (sharpchin, stripetail, and yellowtail rockfish north; English and rex soles) demonstrated adequate frequencies of occurrence (> 10% per year) to be considered for index development (Table 23). Final design strata used in the GLMMs for those stocks are shown in Figure 21 to Figure 25. Year-strata effects were assumed fixed with no interactions for both the binomial and positives models. The Triennial Survey assumes no vessel effects, while the NWFSC annual survey assumed random vessel effects.

Model comparisons and selection are given in Table 24. Lognormal error structure was chosen over gamma in most instances based on the deviance criterion. The suggestion to use a combined triennial survey with lognormal error structure for yellowtail rockfish north was made late in the STAR panel review, so no gamma model is provided for comparison. All chosen models demonstrated good effective sample sizes and acceptable Q-Q plots (Figure 26 to Figure 28). Final index time series used in the base case models are given in Table 25.

2.1.4.3 Power plant impingement indices

The power plant impingement index represents data collected from coastal cooling water intakes at five Southern California electrical generating stations from 1972 through 2011 (and ongoing). These data have been previously described and published by Love et al. (1998) and Miller et al. (2009) with respect to trends in abundance of *Sebastes* species and queenfish (*Seriphus politus*), respectively, as well as in Field et al. (2010) with respect to the development of a recruitment (age-0 abundance) estimate for bocaccio rockfish. The latter index was estimated to be the best performing of four potential pre-recruit indices for this species, and is currently included in the most recent bocaccio update (Field 2011). The dataset includes observations on as many as 1.8 million fish encountered in three basic types of power plant impingement surveys (E. Miller unpublished data.). Of the three principle “types” of data, the most reliable data are the “heat treatment" data, in which a known volume of water is treated at high temperatures to kill off biofouling organisms, and all fishes are subsequently enumerated. Fish are identified to the lowest possible taxon, and a total weight and standardized length measurements are obtained for all species, although such data is not as complete in some of the early years. The frequency of all of these sampling methods is irregular, as a result of changes in operating schedules, regulatory requirements, energy demands and changes in ownership over time. However, the time series is extensive; sampling is distributed relatively evenly across all months as well, and has continued to show considerable promise as a relative abundance index.

Data from over 1700 heat treatments, from five different power stations (e.g., locations) are currently available (data from one additional plant may become available in the near future, as may data from other operations). Table 26 shows the number of heat treatment per station samples for the five power plants currently available by year. Table 27 shows the number of positive occurrences by species from the dataset in Table 26, for five of the more abundant rockfish species: bocaccio, brown, grass, olive, and vermilion (*Sebastes paucispinis, S. auriculatus, S. rastrelliger, S. serranoides*, and *S. miniatus*). Data on many other *Sebastes* species is present, but likely to be too sparse to be informative, although there is considerable data for California scorpionfish (*Scorpaena guttata*). Note that size data (mean weight and length) are available for most species in many of the most recent years. These data indicate that while some species are present almost exclusively as young-of-the-year (YOY), others, including brown rockfish and grass rockfish, are encountered as both YOY, settled juveniles, and subadults (infrequently to mature adult sizes), with suggestions of strong cohorts in some of the size data.

Abundance indices were developed using a Delta-GLM (generalized linear model) approach that is consistent with past stock assessments as well as other types of survey data used in the data-moderate models. Year effects are independently estimated covariates which reflect a relative index of abundance for each year, error estimates for these parameters are developed with a jackknife routine. Seasonal effects were also included, and power station (location) effects were modeled to represent what seem to be fairly substantial differences in catchability by power plant. A preliminary index of brown rockfish (Figure 29) was developed based on the number of encountered animals, and suggests patterns that are consistent with those from the recreational CPUE index used in the assessment. However, as the average size appears to vary substantially from year to year with some suggestion of cohorts moving through the sampling frame, an index based on the total biomass of encountered animals may be more appropriate.

2.1.5 Fishery-dependent indices

2.1.5.1 Trip-based Recreational CPUE

From 1980 to 2003 the Marine Recreational Fisheries Statistical Survey (MRFSS) program sampled landings at dockside (called an "intercept") upon termination of recreational fishing trips. Data were not collected from 1990-1992 due to lack of funding, and the time series is truncated at 2003 due to regulatory changes. The major advantages of this time series are its length (24-year span) and spatial coverage (U.S.-Mexico border to OR-WA border). Although the program sampled various fishing modes, only the party and charter boat (a.k.a. commercial passenger fishing vessel) samples are used in the present analyses due to their relatively large and diverse catches.

The raw data are available from RecFIN (http://www.recfin.org/), and are aggregated by YEAR and bi-monthly sampling period (called a WAVE). The relevant data type (dockside sampler-examined catch, or "Type 3" records in RecFIN) includes catch and effort information aggregated by trip. The catch represents retained fish, effort is angler-reported, and location information includes intercept site (reduced to COUNTY) and distance from shore (AREA_X, a binary variable indicating inside/outside 3 miles). A summary of sample sizes by YEAR and COUNTY is given in Table 28.

Data preparation

Each entry in the RecFIN Type 3 database corresponds to a single fish examined by a sampler at a particular survey site. Since only a subset of the catch may be sampled, each record also identifies the total number of that species possessed by the group of anglers being interviewed. The number of anglers and the hours fished are also recorded. Unfortunately the Type 3 data do not indicate which records belong to the same boating trip. Because our aim is to obtain a measure of catch per unit effort, it is necessary to separate the records into individual trips. For this reason trips must be inferred from the RecFIN data. This is a lengthy process, and is outlined in Appendix RecFIN A. After applying the trip identification algorithm, an estimated 12222 trips were available for analysis. The total number of sampled trips per year varies from 274 to 1064, and the number of samples per county varies from 2 to 2301 (Table 28). For each of the recreationally important rockfish species scheduled for data-moderate assessments in 2013 (yellowtail, brown, copper, and China rockfishes) we calculated the total number observed in sampler-examined trips by YEAR and COUNTY and the corresponding number of positive trips. As an alternative coarser geographic descriptor, we aggregated COUNTY into REGION, which had three values, Mexico to Pt. Conception (SOUTH), Pt. Conception to Cape Mendocino (CENTRAL), and Cape Mendocino to Astoria at the OR/WA border (NORTH). Note that the regional break at Cape Mendocino is different than the CA/OR break in the original RecFIN data.

To identify trips as effective effort for a given target species, we apply the binary regression approach of Stephens and MacCall (2003). Based on presence/absence of species co-occurring with the target species, this method generates a probability of observing the target species in a given trip. We wish to exclude trips with a low probability of observing the target. Stephens and MacCall suggested a threshold probability that balances the false positives and false negatives. Using this criterion, most trips not exceeding the threshold probability would not catch the target species, but since some trips reflect a mixture of targets, a subset of trips in which the target was reported are also excluded from the dataset ("false positives"). Whereas Stephens and MacCall used a logistic regression, we examine a suite of transformations including logit, probit, complementary log-log (cloglog) and an "inverted" complementary log-log link function, modeling absences (cloglogABSENCE). In most cases the latter was the preferred transformation.

RecFIN-based Indexes (1980-2003)

RecFIN annual abundance indices are estimated using the delta-GLM approach (Lo et al., 1992; Stefansson, 1996). Explanatory variables available in the Type 3 data are YEAR, WAVE (2-month period), COUNTY or REGION, and AREA_X (distance from shore). The distance from shore is a binary categorical variable, which indicates whether the majority of effort was within or beyond 3 miles of shore.

Once the trip data are filtered according to the Stephens-MacCall method, we determine the best link function for the binomial portion of the model and the best probability model (density function) for the positive portion of the model. The link functions we considered were logit, probit, complementary log-log (cloglog), and inverse cloglog. The probability distributions we considered for the positive model were the gamma and the lognormal distributions. For each link function we fit a binomial GLM to the data and used AIC as a model selection criterion. Similarly, for each positive probability model we fit a GLM and used AIC to determine the relative goodness of fit.

Once a link function and probability model have been selected, further model selection analysis is performed to determine which explanatory variables to use. Because we ultimately seek a yearly CPUE index, we force YEAR to be a variable in the model. We use BIC as a model selection criterion, testing for interactions with YEAR effects. By the BIC criterion, all interaction terms were dropped in every RecFIN index.

<u>Brown rockfish (central area)</u>
The RecFIN (dockside sampling) 1980 to 2003 data for the central areas (Pt. Conception to Cape Mendocino) were subsetted by Stephens-MacCall species filtering, and were then used in a delta-GLM. Index values and CVs used in the base model are presented in Table 29. The index is shown in Figure 30.

<u>Brown rockfish (southern area)</u>
The RecFIN (dockside sampling) 1980 to 2003 data for the southern area (Pt. Conception to the U.S.-Mexico border) were subsetted by Stephens-MacCall species filtering, and were then used in a delta-GLM. Index values and CVs used in the base model are presented in Table 30. The index is shown in Figure 31.

<u>China rockfish (northern area)</u>
The RecFIN (dockside sampling) 1980 to 2003 data for the northern area (Cape Mendocino to Astoria) were subsetted by Stephens-MacCall species filtering, and were then used in a delta-GLM. Index values and CVs used in the base model are presented in Table 31. The index is shown in Figure 32.

<u>China rockfish (central area)</u>
The RecFIN (dockside sampling) 1980 to 2003 data for the central area (Pt. Conception to Cape Mendocino) were subsetted by Stephens-MacCall species filtering, and were then used in a delta-GLM. Index values and CVs used in the base model are presented in Table 32. The index is shown in Figure 33.

<u>Copper rockfish (south area)</u>
The RecFIN (dockside sampling) 1980 to 2003 data for the southern area (Mexico to Pt. Conception) were subsetted by Stephens-MacCall species filtering, and were then used in a delta-GLM.

Species Filtering: The initial dataset (N = 7469, pos = 517) was filtered using a binomial GLM with presence-absence of other commonly occurring species as indicator variables. Alternative transforms and their AIC values were logit (2423), probit (2394) and cloglogAbsence (2369), giving strong support for the latter. The species coefficients are shown in Figure 34 and Figure 35. The 522 records with the highest fitted probabilities were retained (the probability threshold was 0.322).

Delta-GLM: The selected data (N = 522, pos = 275) contained YEAR and three possible additional effects, WAVE (6 two-month bins), COUNTY (5 levels), and AREA_X (2 levels), which was a binary indicator of inside/outside three miles from shore. Abundance was measured as catch per angler hour, and the positive model was weighted by angler hours. The distribution for positives was lognormal (which was strongly favored over gamma by a deltaAIC of 45). The binary model used a logit transformation which was indistinguishable from the alternatives. In both submodels, stepwise BIC removed all interaction terms and then removed fixed effects leaving only YEAR and COUNTY (Table 33). The YEAR effects are shown in Figure 36.

<u>Copper rockfish (north-central area)</u>
The RecFIN (dockside sampling) 1980 to 2003 data for the North and Central areas (Pt. Conception to Astoria) were subsetted by Stephens-MacCall species filtering, and were then used in a delta-GLM.

Species Filtering: The initial dataset (N = 4291, pos = 833) was filtered using a binomial GLM with presence-absence of other commonly occurring species as indicator variables. Alternative transforms and their AIC values were logit (3141), probit (3133) and cloglogAbsence (3126), giving strong support for the latter. The species coefficients are shown in Figure 37. The 841 records with the highest fitted probabilities were retained (the probability threshold was 0.360).

Delta-GLM: The selected data (N = 841, pos = 476) contained YEAR and three possible additional effects, WAVE (6 two-month bins), COUNTY (14 levels) or broader REGION (2 levels), and AREA_X (2 levels) which was a binary indicator of inside/outside three miles from shore. Abundance was measured as catch per angler hour, and the positive model was weighted by angler hours. The distribution for positives was lognormal (which was strongly favored over gamma by a deltaAIC of 63). The binary model used a logit transformation which was indistinguishable from the alternatives. In the positive submodel, stepwise BIC removed all interaction terms and then removed fixed effects leaving only YEAR and REGION (which was favored over COUNTY). The binomial portion removed all effects, leaving only YEAR (Table 34). The YEAR effects are shown in Figure 38.

2.1.5.2 Observer-based Recreational CPUE from CPFVs

Central California Observer Indexes (1988-1998+) CenCalOBS
Historical CPFV observer data from 1988 to 1998 for the Central California area (Pt. Conception to Cape Mendocino) were combined with data from two ongoing onboard observer programs: CDFW (1999-2011), and CalPoly (2003-2011). Data from CDFW and CalPoly were formatted to match the historical format (catch and effort for drifts were aggregated within a site and trip).

Prior to any analyses, a preliminary data filter was applied. Trips and drifts meeting the following criteria were excluded from analyses:

- Trips in which 70% or more of the observed catch composition was not bottomfish (CDFW data only).

Drifts meeting the following criteria were excluded from analyses:

- Drifts in San Francisco Bay (Golden Gate Bridge was used as the border);
- Drifts missing both starting and ending location (latitude/longitude) (CalPoly and CDFW data only); and
- Drifts identified as having possible erroneous location or time data (CalPoly and CDFW data only).

Fishing time was limited to include 95% of the data to remove potential outliers for the CDFW and CalPoly data. Fishing time outliers were not removed from the historical data because fishing time was aggregated over multiple drifts at a specific location. Remaining drifts were between 5 and 69 minutes for the CDFW data and between 4 and 54 minutes for the CalPoly data. The number of observed anglers was limited to include 95% of the CDFW data, resulting in observed anglers between 4 and 19 persons.

Fishing locations in the historical database are assigned to fishing sites, defined by CDFW's historical onboard observer database (pers. comm., Deb Wilson-Vandenberg, CDFW). A site is established the first time it is visited and that site is recorded as a fishing location for all future trips fishing at the same location. For this analysis, fishing sites were bounded by creating Thiessan polygons over the observed range.

For each species, the following methods were applied to identify regions of suitable habitat (region), and to determine the number of drifts to include in the analysis. The drift-specific locations from the CDFW and CalPoly data were used to define the suitable habitat. The locations of positive encounters were mapped, using the drift starting locations. Regions were defined by creating detailed hulls (similar to an alpha hull) with a 0.01 decimal degree buffer around a location or cluster of locations (Data East 2003). Any portion of a region that intersected with land was removed. As an example of the buffers, a region with only one positive encounter has an ellipsoid area of 3.22 km^2. Each drift (including both positive and zero-catch) was assigned to the region with which it intersected. Drifts that did not intersect with a region were considered structural zeroes, i.e., outside of the species habitat, and excluded from the analyses. The regions of suitable habitat were then assigned to the intersecting historical fishing sites (Thiessan polygons). If a fishing site included suitable habitat from more than one region, the regions were combined and the area within the fishing sites were summed. This aggregation allows area-weighted indices to be calculated at the level of fishing site or region. All historical data (positive and zero-catch site visits) occurring within a fishing site of suitable habitat were retained for analyses. Site visits from the historical data that occurred in a polygon identified as having no suitable habitat were excluded from the analyses.

Drifts from the same trip (for CalPoly and CDFW data) occurring within the same fishing site were collapsed to maintain consistency with the historical data. CPUE was calculated as $\sum catch \,/\, \sum effort$ for a site visit within a trip. For all species, catch included both observed retained and discarded fish. An average depth was calculated as the average of the average depth over all collapsed drifts.

For each species, data were filtered to exclude Thiessan polygons that did not consistently produce catch of the species of interest (i.e., having fewer than 5 years with positive observations).

<u>Brown rockfish</u>
Onboard CPFV Data: Prior to filtering, the combined set of historical and current CDFW onboard samples and the CalPoly samples (N = 5176; pos = 1525) contained 33 regions identified as suitable brown rockfish habitat. Only one positive observation occurred deeper than 40 fathoms, so only records with an average depth less than 40 fathoms were retained. Data for the year 2000 was excluded due to small sample size (22 observations total, 9 positive).

Testing for differences in CPUE trend among regions: Although 14 regions had at least 5 years of positive observations for brown rockfish, sampling coverage was insufficient to test for difference in CPUE trends among regions (i.e., an interaction between YEAR and REGION variables). To examine spatial differences in CPUE trends, regions were aggregated into 2 'super regions' (north and south of Monterey, CA). The interaction between YEAR and REGION was not retained by stepwise BIC in either the lognormal or binomial submodels.

Delta-GLM: The selected data (N = 2158; pos = 1159) contained categorical variables for YEAR (23 levels) and two possible additional effects, MONTH (12 levels), REGION (2 levels), and 10-fathom depth bins ("DEP10", 4 levels). The distribution for positives was lognormal (which was favored over gamma by a deltaAIC of 10.7). The final positive and binomial models for the index retained YEAR, DEP10, and REGION effects (Table 35; Figure 39).

China rockfish

Onboard CPFV Data: Prior to filtering, the combined set of historical and current CDFW onboard samples and the CalPoly samples (N = 6904; pos = 1585) contained 34 regions identified as suitable China rockfish habitat. China rockfish is a shallow, nearshore species, and only records with an average depth less than 50 fathoms were retained. Data for the year 2000 was excluded due to small sample size.

Testing for differences in CPUE trend among regions: Although 18 regions had at least 5 years of positive observations for brown rockfish, sampling coverage was insufficient to test for difference in CPUE trends among regions (i.e., an interaction between YEAR and REGION variables). To examine spatial differences in CPUE trends, regions were aggregated into 3 'super regions' (north of San Francisco, Half Moon Bay to Santa Cruz, and from Monterey to Morro Bay). The interaction between YEAR and REGION was retained by stepwise AIC in the lognormal, but not the binomial, submodel. To develop an index for Central California that integrated across area-specific trends in abundance, we developed an area-weighted index using coefficients from the Year/Region interaction terms multiplied by area estimates for each region. The trend in year effects from the area-weighted index was similar to the main effects model (selected as the best model by BIC; Figure 40). The interaction between YEAR and REGION was not retained by stepwise BIC in either the lognormal or binomial submodels.

Delta-GLM: The selected data (N = 3741; pos = 1162) contained categorical variables for YEAR (23 levels) and two possible additional effects, MONTH (12 levels), REGION (3 levels), and 10-fathom depth bins ("DEP10", 5 levels). The distribution for positives was lognormal (which was favored over gamma by a deltaAIC of 132). The final positive and binomial models for the index retained YEAR, DEP10, and REGION effects. The YEAR effects are shown in Table 36 and Figure 41.

Copper rockfish

Onboard CPFV Data: Prior to filtering, the combined set of historical and current CDFW onboard samples and the CalPoly samples (N = 7727; pos = 2615) contained 38 regions identified as suitable copper rockfish habitat. Records with an average depth deeper than 60 fathoms were discarded due to the small number of positives. Data for the year 2000 was excluded due to small sample size.

Testing for differences in CPUE trend among regions: Although 21 regions had at least 5 years of positive observations for copper rockfish, sampling coverage was insufficient to test for difference in CPUE trends among regions (i.e., an interaction between YEAR and REGION variables). To examine spatial differences in CPUE trends, regions were aggregated into 4 'super regions' (roughly Point Arguello to Point Lopez, the Monterey/Carmel area, Santa Cruz to Half Moon Bay, and the Farallon Islands to Point Reyes). The interaction between YEAR and REGION was not retained by stepwise BIC in either the lognormal or binomial submodels.

Delta-GLM: The selected data (N = 5024; pos = 2079) contained categorical variables for YEAR (23 levels) and two possible additional effects, MONTH (12 levels), REGION (4 levels), and 10-fathom depth bins ("DEP10", 6 levels). The distribution for positives was lognormal (which was favored over gamma by a deltaAIC of 217). The final positive and binomial models for the index retained YEAR, DEP10, and REGION effects. The YEAR effects are shown in Table 37 and Figure 42. Copper rockfish has a slightly deeper distribution compared to other "nearshore" rockfish (e.g., China), so the index was calculated from data excluding regulatory periods and locations with 20-fathom depth restrictions. The difference in year effects was minimal (Figure 43).

Southern California Observer Indexes (1999-2011) SoCalOBS
Data for the southern California indices are from the California Department of Fish and Wildlife (CDFW) Onboard Observer Program (1999-2011) (Reilly et al. 1998). Data were analyzed at the drift level and catch was taken to be the sum of observed retained and discarded fish.

Prior to any analyses, a preliminary data filter was applied. Trips and drifts meeting the following criteria were excluded from analyses:

- Trips outside U.S. waters; and
- Trips in which 70% or more of the observed catch composition was not bottomfish.

Drifts meeting the following criteria were excluded from analyses:

- Drifts deeper than 60 fathoms (due to depth regulations);
- Drifts in conservation areas, i.e., Cowcod Conservation Areas and MPAs, established prior to 2012 and prohibit the take of rockfish;
- Drifts in San Diego Harbor;
- Drifts missing both starting and ending location (latitude/longitude); and
- Drifts identified as having possible erroneous location or time data.

Fishing time and number of observed anglers were limited to include 95% of the data to remove potential outliers. Remaining drifts were between 5 and 119 minutes and observed anglers between 4 and 19 persons.

For each species, the following methods were applied to identify regions of suitable habitat, and to determine the number of drifts to include in the analysis. The locations of positive encounters were mapped, using the drift starting locations. Regions of suitable habitat were defined by creating detailed hulls (similar to an alpha hull) with a 0.01 decimal degree buffer around a location or cluster of locations (Data East 2003). Any portion of a region that intersected with land was removed. As an example of the buffers, a region with only one positive encounter has an ellipsoid area of 3.22 km^2. Each drift (both positive and zero-catch) was assigned to the region with which it intersected. Drifts that did not intersect with a region were considered structural zeroes, i.e., outside of the species habitat, and not used in analyses. For each species, data were filtered to exclude regions that did not consistently produce catch of the species of interest (i.e., having fewer than 5 years with positive observations).

<u>Brown rockfish</u>
ODFW Onboard Data: The data pre-region filtered (N = 11906; pos = 1126) contained 65 regions identified as suitable brown rockfish habitat.

Preliminary data analysis: Brown rockfish were never observed deeper than 40 fathoms, and observations deeper than 40 fathoms were excluded from the analysis. Depth was collapsed to two 15-fathom depth bins to increase sample sizes within depth bins.

Testing for differences in CPUE trend among regions: Although 17 regions (75% of the total km^2 defined as suitable habitat) had at least 5 years of positive observations for brown rockfish, sampling coverage was insufficient to test for difference in CPUE trends among regions (i.e., an interaction between YEAR and REGION variables). To examine spatial differences in CPUE trends, regions were aggregated into 2 'super regions,' 1) north of San Pedro, and 2) south of San Pedro. Trends in average CPUE in each super region suggested a potential difference among regions that was supported by stepwise AIC model selection (for the binomial GLM only). The main-effects model has more pronounced peak relative abundance than the area-weighted model, but both exhibit the same increase in relative abundance (Figure 44). The areas are weighed fairly evenly (44% North of San Pedro and 56% South of San Pedro), but the temporal trends between the regions do differ (Figure 45). The main-effects model was retained for the index.

Delta-GLM: The selected data (N = 9036; pos = 999) contained categorical variables for YEAR (11 levels) and two possible additional effects, MONTH (12 levels), REGION (2 levels), and 15-fathom depth bins ("DEP15", 2 levels). The distribution for positives was lognormal (which was strongly favored over gamma by a deltaAIC of 158). The binary model used a logit transformation which was indistinguishable from the alternatives. In both submodels, stepwise BIC removed all interaction terms. The final positive without interactions retained YEAR, DEP10, and REGION, and MONTH, and the binomial portion retained YEAR, REGION, and MONTH (Table 38). The YEAR effects are shown in Figure 46.

<u>Copper rockfish (south area)</u>
ODFW Onboard Data: The data pre-region filtered (N = 12580; pos = 1471) contained 84 regions identified as suitable copper rockfish habitat.

Preliminary data analysis: Depth was collapsed to four 15-fathom depth bins to increase sample sizes within depth bins.

Testing for differences in CPUE trend among regions: Although 19 regions (68% of the total km^2 defined as suitable habitat) had at least 5 years of positive observations for copper rockfish, sampling coverage was insufficient to test for difference in CPUE trends among regions (i.e., an interaction between YEAR and REGION variables). To examine spatial differences in CPUE trends, regions were aggregated into 2 'super regions,' 1) Coastal, and 2) Channel Islands. Trends in average CPUE in each super region suggested a potential difference among regions that was supported by stepwise AIC model selection (for both the positive and binomial GLMs). The main-effects model has more pronounced peak relative abundance than the area-weighted model, but both exhibit the same increase in relative abundance (Figure 47). The coastal areas accounted for 65% of the total copper rockfish "suitable habitat," with the other 35% from the Channel Islands (Figure 47). The main-effects model was retained for the index.

Delta-GLM: The selected data (N = 9378; pos = 1271) contained categorical variables for YEAR (11 levels) and two possible additional effects, MONTH (12 levels), REGION (2 levels), and 15-fathom depth bins ("DEP15", 4 levels). The distribution for positives was lognormal (which was strongly favored over gamma by a deltaAIC of 161.4). The binary model used a logit transformation which was indistinguishable from the alternatives. In both submodels, stepwise BIC removed all interaction terms. The positive and binomial models without interactions retained YEAR, REGION, MONTH, and DEP15 (Table 39). The YEAR effects are shown in Figure 48.

Northern CA and OR Indexes (2001-2012) NoCalOROBS
Data were combined from the Oregon Department of Fish and Wildlife (ODFW) Observer Program (2001, 2003-2012) (Monk et al. in prep.) and the California Department of Fish and Wildlife (CDFW) Observer Program (1999-2011) (Reilly et al. 1998). Data were analyzed at the drift level and catch was taken to be the sum of observed retained and discarded fish.

Prior to any analyses, a preliminary data filter was applied. Trips and drifts meeting the following criteria were excluded from analyses:

- Northern California trips in which 70% or more of the observed catch composition was not bottomfish; and
- ODFW halibut-targeted trips were excluded.

Drifts meeting the following criteria were excluded from analyses:

- Drifts deeper than 40 fathoms (due to depth regulations);
- Drifts within the current Stonewall Bank Yelloweye Rockfish Conservation;
- Drifts within Arcata Bay, Humboldt Bay, or South Bay near Eureka, CA;
- Drifts missing both starting and ending location (latitude/longitude); and
- Drifts identified as having possible erroneous location or time data.

Fishing time was limited to include 95% of the data to remove potential outliers. In Oregon, drifts with fishing times between 3 and 34 minutes were retained. In northern California, drifts with fishing times between 2 and 46 minutes were retained. The number of observed anglers from the northern California was also limited to include 95% of the data, resulting in observed anglers between 4 and 19 persons.

For each species, the following methods were applied to identify regions of suitable habitat, and to determine the number of drifts to include in the analysis. The locations of positive encounters were mapped, using the drift starting locations. Regions of suitable habitat were defined by creating detailed hulls (similar to an alpha hull) with a 0.01 decimal degree buffer around a location or cluster of locations (Data East 2003). Any portion of a region that intersected with land was removed. As an example of the buffers, a region with only one positive encounter has an ellipsoid area of 3.22 km^2. Each drift (both positive and zero-catch) was assigned to the region with which it intersected. Drifts that did not intersect with a region were considered structural zeroes, i.e., outside of the species habitat, and not used in analyses. For each species, data were filtered to exclude regions that did not consistently produce catch of the species of interest (i.e., having fewer than 5 years with positive observations).

For each species, data were filtered to exclude regions that did not consistently produce catch of the species of interest (i.e., having fewer than 5 years with positive observations). This filter excluded all drifts from northern California (north of 40°10' N lat.) for all species. The indices for the northern region represent only data from the ODFW Observer Program. The data from northern California were too sparse to include in the analyses.

<u>China rockfish (north region)</u>
ODFW Onboard Data: The data pre-region filtered (N = 8105; pos = 241) contained 22 regions identified as suitable China rockfish habitat.

Preliminary data analysis: China rockfish were never observed deeper than 30 fathoms, and observations deeper than 30 fathoms were excluded from the analysis. Data by month was too sparse for the analysis, and month was collapsed to "WAVE", e.g., March-April = 2.

Testing for differences in CPUE trend among regions: Although 8 regions (71% of the total km^2 defined as suitable habitat) had at least 5 years of positive observations for China rockfish, sampling coverage was insufficient to test for difference in CPUE trends among regions (i.e., an interaction between YEAR and REGION variables). To examine spatial differences in CPUE trends, regions were aggregated into 2 'super regions,' 1) Northern Oregon (Tillamook and

Lincoln Counties), and 2) Southern Oregon (Coos and Curry Counties). Trends in average CPUE in each super region suggested a potential difference among regions that was supported by stepwise AIC model selection (for both the positive and binomial GLMs; Figure 49). However, development of the area-weighted index resulted in little change over the main-effects model, and the main effects model was retained for the index.

Delta-GLM: The selected data (N = 7043; pos = 198) contained categorical variables for YEAR (11 levels) and two possible additional effects, WAVE (4 levels), REGION (2 levels), and 10-fathom depth bins ("DEP10", 3 levels). The distribution for positives was lognormal (which was favored over gamma by a deltaAIC of 18.38). The binary model used a logit transformation which was which was indistinguishable from the alternatives. In both submodels, stepwise BIC removed all interaction terms. The final positive model without interactions retained YEAR, WAVE, and REGION, and the binomial portion retained only YEAR (Table 40). The YEAR effects are shown in Figure 50.

<u>Copper rockfish (north region)</u>
ODFW Onboard Data: The data pre-region filtered (N = 7550; pos = 185) contained 21 regions identified as suitable copper rockfish habitat.

Preliminary data analysis: Copper rockfish were never observed deeper than 30 fathoms, observations deeper than 30 fathoms were excluded from the analysis. Depth was collapsed into two 15-fathom depth bins ("DEP15"). Data by month was too sparse for the analysis, and month was collapsed to "WAVE", e.g., March-April = 2.

Testing for differences in CPUE trend among regions: Although 5 regions (61% of the total km^2 defined as suitable habitat) had at least 5 years of positive observations for copper rockfish, sampling coverage was insufficient to test for difference in CPUE trends among regions (i.e., an interaction between YEAR and REGION variables). To examine spatial differences in CPUE trends, regions were aggregated into 2 'super regions,' 1) Northern Oregon (Lincoln County), and 2) Southern Oregon (Coos County). Trends in average CPUE in each super region suggested a potential difference among regions that was supported by stepwise AIC model selection (for the positive GLM only). The development of the area-weighted index differentiates from the main-effects model in 2001 and 2007 (Figure 51). The area-weighted model can be run as a sensitivity analysis, and the main-effects model is used in the base case model for copper rockfish.

Delta-GLM: The selected data (N = 5786; pos = 145) contained categorical variables for YEAR (11 levels) and two possible additional effects, WAVE (4 levels), REGION (2 levels), and 15-fathom depth bins ("DEP15", 2 levels). The distribution for positives was lognormal (which was favored over gamma by a deltaAIC of 5.78). The binary model used a logit transformation which was which was indistinguishable from the alternatives. In both submodels, stepwise BIC removed all interaction terms. The positive model retained YEAR and REGION, and the binomial portion retained only YEAR, DEP10, and REGION (Table 41). The YEAR effects are shown in Figure 52.

2.2 History of Modeling Approaches

2.2.1 Previous assessments

Yellowtail north and English sole had previous full (category 1) stock assessments performed, which included indices of abundance, length/age compositions, and recruitment estimation. Yellowtail rockfish and English sole have a long history of management being informed by fisheries models, dating back to the early 1980s. The last assessment for yellowtail was performed in 2004 using an age-structured model written in AD Model Builder, but not Stock

Synthesis. The most recent English sole assessment was conducted in 2007 using Stock Synthesis 2. The remaining species have no prior category 1 or 2 assessments.

Dick and MacCall (2010) estimated overfishing levels (OFLs) for brown, China, copper, yellowtail (south of 40° 10′ N lat.), sharpchin, and stripetail rockfishes as well as for rex sole using Depletion-Based Stock Reduction Analysis. These OFLs were adopted for the PFMC's 2011-12 and 2013-14 management cycles, as components of the stock complex OFLs associated with each species.

2.3 Model Description

Two assessments models (Extended Depletion-Based Stock Reduction Analysis and extended Simple Stock Synthesis) are applied to the removal and index data available for each stock. Both methods were approved in 2012 by a methodology review panel[1] as appropriate for estimating status and OFLs. Initial model exploration included running both modeling approaches for each stock, but resource limitations during the STAR panel necessitated the following division of labor between the two approaches: Assessments of nearshore rockfishes (3 species) relying on fishery-dependent recreational-based indices were done using XDB-SRA; shelf-slope species (4 species) using fishery-independent trawl surveys were done using exSSS.

2.3.1 Bayesian Stock Reduction Analysis (Extended Depletion-Based Stock Reduction Analysis, XDB-SRA)

Depletion-Based Stock Reduction Analysis (DB-SRA; Dick and MacCall, 2010) is a non-age-structured catch-based yield estimator currently used by the PFMC to estimate sustainable yields for "data-poor" stocks. The method generates prior predictive distributions of OFL and other quantities of interest to management (e.g., MSY and unfished biomass) based on a population dynamics model, annual catches, age at maturity, and prior distributions for stock status, natural mortality, and the ratios F_{MSY} / M and B_{MSY} / B_0. For the assessments of "data-moderate" stocks, we developed a simple Bayesian extension of DB-SRA, in which the prior distributions are updated by specification of likelihood functions for the abundance indices, generating posterior distributions for quantities such as stock status, biomass, and sustainable yield (OFL).

2.3.1.1 Population Dynamics Model

We revise the dynamics equation used by Dick and MacCall (2011) to better approximate a time lag in recruitment, rather than a lag in net production. Biomass in each year is defined as

$$B_t = B_{t-1} + P(B_{t-a}) - C_{t-1} + (1 - e^{-M})(B_{t-a} - B_{t-1}) \quad (1)$$

where B_t represents mature and vulnerable biomass at time *t* and C_t represents catch at time *t*. All sources of catch within an assessment were combined into one fleet, with assumed 'knife-edge' selectivity set equal to age at maturity. *P* is a latent production function based on biomass *a* years earlier, where *a* is the age that a fish matures and becomes vulnerable to the fishery. Following Dick and MacCall (2011), we use a hybrid production function based on the Pella-Tomlinson-Fletcher (PTF) and Graham-Schaefer models. The last term in equation (1) adjusts the natural mortality component of net production to reflect biomass at time B_{t-1} rather than B_{t-a} (Aalto et al., 2015). If, for example, B_{t-a} is larger than B_{t-1}, a model without this correction factor would underestimate production, and vice versa. Note that the correction term disappears when lag times for recruitment and survival are the same.

[1] Assessment Methods for Data-Moderate Stocks: Report of the Methodology Review Panel Meeting http://www.pcouncil.org/wp-content/uploads/H3a_ATT1_DATA_MOD_RPT_SEP2012BB.pdf.

2.3.1.2 Likelihood components

For each abundance index, I, we assume a normal likelihood function for log-scale biomass and index values, scaled by a catchability coefficient, q.

$$l(B, q, a; I) = \prod_{i=1}^{n} N(log(I_i/q); log(B_i), v_i + a). \quad (2)$$

The variance of the normal likelihood is composed of an annual variance component, v_i (estimated external to the model and assumed known for the i^{th} year), and an additive variance term, a, that is common to all years and estimated in the model.

2.3.1.3 Prior Distributions

Relative Depletion (Δ): Since Δ (= $1\text{-}B_t/B_0$) is constrained to be between 0 and 1, we use a truncated beta distribution as a prior. The distribution was truncated below 0.01 and above 0.99 to exclude improbable values of stock status.

The 2012 STAR Panel recommended using PSA vulnerability scores (Cope et al. 2011) to establish depletion priors for data-moderate assessments. Unfortunately, no quantitative information was captured in the Panel Report, so the analysis had to be reconstructed. The PSA scores reflecting pre-2000 fishery management were provided by John DeVore (pers. comm.) and corresponding depletion was the relative abundance in 2000. Pacific hake was deleted from the dataset, giving N=31 cases (Figure 53).

The STAR Panel recommended using three bins, but their specifications were not recorded. The vertical lines in Figure 53 show bin boundaries at vulnerability scores of 1.87 and 2.33. Depletion priors were calculated for the left "Low V" bin, the central "Middle V" bin, and an "Uninformative" case reflecting the entire dataset. Means and standard deviations were used to specify the priors as beta distributions (Figure 54). Except for English sole and yellowtail rockfish, we do not have pre-2000 PSA vulnerability scores for the data-moderate species under present consideration, and use scores reported by Cope et al. (2011). Brown rockfish (1.99), China rockfish (2.23), and copper rockfish (2.27) fell in the "Middle V" bin.

Natural mortality rate (M): For species that have not been previously assessed, we assumed a lognormal distribution with arithmetic mean derived from Hoenig's equation for total mortality, Z.

$$log(Z) = 1.710 - 1.084 \times log(A_{max}). \qquad (3)$$

The arithmetic mean for M was bias-corrected using a log-scale standard deviation 0.4. Uncertainty for this parameter was informed by Hoenig's regression data.

B_{MSY}/B_0: We assume a truncated beta distribution for this parameter with bounds 0.05 and 0.95, chosen to exclude unrealistic parameter values. The mean of the prior distribution was 0.4 for rockfish, with a standard deviation of 0.15. This prior is centered on the PFMC proxy for rockfish, and acknowledges considerable uncertainty in this quantity.

F_{MSY}/M: We assume a lognormal distribution, with arithmetic mean 0.97 and log-scale standard deviation 0.46. These parameter values are based on the work of Zhou et al. (2012) who conducted a meta-analysis of the ratio F_{MSY}/M for 245 stocks. Specifically, we used the prior for teleosts (n=88 species) and approximated the log-scale standard deviation of the prior by multiplying the reported standard error by the square root of the sample size.

Additive variance (a): A uniform distribution was chosen as a prior for this parameter. The range for each index was chosen through visual inspection of preliminary importance sampling results and confirmation that posterior draws were not truncated.

Catchability (q): Catchability coefficients were not estimated. The likelihood was derived by integrating over $log(q)$ with a diffuse, improper prior (uniform from $-\infty$ to $+\infty$).

2.3.1.4 Monte Carlo Simulation of Posterior Distributions

Starting from DB-SRA results (i.e., prior predictive distributions), Sampling Importance Resampling (SIR; Rubin, 1988) is easily implemented by calculating the likelihood associated with each parameter vector, followed by resampling from the prior distributions using the likelihoods as weights.

When SIR was found to be computationally inefficient, we generated results based on an Adaptive Importance Sampling (AIS) algorithm (see Kinas (1996) for details). We use the routine described by West (1993) for reducing the mixture, although in place of simple Euclidean distance we use standardized Euclidean distance to determine the nearest neighboring points (the standardized distances are not sensitive to differences in magnitude among parameters). During each iteration, we draw approximately 2000 points from the current envelope and then reduce the mixture to 500 components. A multivariate normal kernel is employed, and we follow the guidelines discussed by West (1993) for choosing the smoothing parameter.

2.3.1.5 Convergence Criteria

For SIR runs, we examined the maximum value of the importance sampling weights to determine if a large number of posterior draws were based on a single run. Runs with maximum weights less than 0.01 showed little change in posterior distributions under further sampling. For AIS runs, a measure of entropy relative to uniformity of the weights (West, 1993) was also monitored. The adaptive algorithm was stopped if the entropy criterion reached a threshold value of 0.92.

2.3.2 Extended Simple Stock Synthesis (exSSS)

2.3.2.1 Model

Stock Synthesis (SS; Methot and Wetzel 2013) is a flexible age-structured likelihood-based modeling environment used for most west coast groundfish stock assessments. Cope (2013) demonstrated that its flexibility includes application of category 3 (catch-only) models, an approach termed Simple Stock Synthesis (SSS). Extended SSS is intended to be a bridge between SSS and SS by adding indices of abundance to SSS, thus allowing categories 1-3 assessments to be developed and conducted on a common modeling platform. Cope[2] demonstrated the ability of exSSS to adequately replicate full assessments, and the approach was reviewed by a STAR panel and the SCC, both of which recommended its application to data-moderate stocks.

The population model underlying exSSS is sex- and age-structured with a Beverton-Holt stock-recruitment relationship, though recruitment is assumed deterministic. There are four estimated parameters: Male and female natural mortality (M), steepness (h), and the log-value of initial recruitment (lnR_0). The M prior is assumed to be lognormally distributed with mean values provided in Table 1 and a standard deviation of 0.4 (same assumptions used in DB-SRA and

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[2] Cope, J.M. 2012. Extending catch-only Stock Synthesis models to include indices of abundance. Report provided for the Assessment Methods for Data-Moderate Stocks Review Panel, 26-29 June 2012, Seattle, WA.

SSS). Steepness for rockfishes assumes a beta distribution, with parameters based on an update of the Dorn rockfish prior (commonly used in past west coast rockfish assessments) conducted by J. Thorson (pers. comm.) which was reviewed and accepted by the SSC (μ = 0.779; σ = 0.152). The prior used for the flatfishes was the Myers et al. (1999) normally distributed steepness meta-analysis for flatfishes (μ = 0.8; σ = 0.093), also commonly applied to west coast rockfishes. Sensitivity to choice of *M* and rockfish *h* was explored using the Hamel prior for *M* (Table 42; Hamel, pers. comm.) and the old Dorn rockfish *h* prior, respectively. In addition, a likelihood profile on *h* is provided to explore the sensitivity of *M* and derived quantities to the assumed fixed value of *h*. Additional fixed model parameterizations include sex-specific growth, length weight relationships, and maturity-at length (Table 1). Selectivities of fishery and abundance indices are assumed equal to maturity in all cases. Additional variance estimation on abundance indices was also considered. Major likelihood components therefore include fits to the abundance indices and any penalties on priors. Sensitivities of derived quantities to the inclusion of indices of abundance were also explored.

2.3.2.2 Model uncertainty in exSSS

Uncertainty is estimated and compared in three ways: 1) asymptotic variance, 2) Markov Chain Monte Carlo (MCMC), and 3) Adaptive Importance Sampling (AIS). The asymptotic variance is calculated when using SS models and thus simple to obtain, but may underestimate uncertainty (Stewart et al. 2013), thus the need for other methods. For MCMC, a 2,200,000 chain is run (-MCMC 2200000) for each species, with the first 200,000 iterations (-mcscale 200000) undergoing a rescaling of the covariance matrix until a desirable acceptance rate is achieved, and every 2,000th iteration being retained (-mcsave 2000). The first 99 iterations are then removed to leave 1000 draws for the posterior. In past applications of exSSS, converged MCMC models were not always available, thus AIS was also considered as an alternative way to characterize uncertainty. The application to exSSS is described below.

2.3.2.3 Adaptive Importance Sampling (AIS*)*

Sampling importance resampling (SIR) (Ruben 1987, 1988), which samples parameter vectors from a prior distribution taken from a sampling envelope, has been applied in fishery stock assessment for parameter estimation (e.g., Punt 1993; McAllister et al. 1994, Kinas 1996). However, an AIS approach that updates the sampling envelope based upon iterative SIR draws can be beneficial when the best sampling envelope is unknown or not well understood a priori due to correlation among parameters.

To create initial population trajectories, 2000 (N_{init}) Monte Carlo draws from each of the three prior distributions initial parameter draws are fixed in the model where exSSS estimates a *ln(R₀)* value which results in a population that meets the fixed final depletion value, based on the other fixed model parameters. The survey likelihood value from each trajectory given the data is recorded as a measure of the fit of the expected model values to the observed data calculated as:

$$L_i\left(\theta_i \mid data\right) = \sum_{t=1}^{N_t} \frac{\left(\ln\left(I_t\right) - \ln\left(\hat{q}_i B_{t,i}\right)\right)^2}{2\sigma^2} \qquad (0.0)$$

where $\hat{I}_t$ is the observed abundance value in year t, $B_{t,i}$ is the estimated biomass in year t for the i[th] trajectory, $\hat{q}_i$ is the catchability coefficient for the ith trajectory, and σ is the variance.

The likelihood of the i^th trajectory given the data is combined with the prior and posterior probability of the parameter values to calculate the sampling envelope weights:

$$w_i = \frac{L_i\left(\theta_i \mid data\right) P_i}{Pr_i} \tag{0.0}$$

where P_i is the prior probability for the drawn parameter set and Pr_i is the posterior probability of the drawn parameter set. In the first iteration of the AIS, the prior and posterior distributions are equal and hence cancel each from the numerator and the denominator of equation 1.2. A sample with replacement of size 0.25 N_{init} with probability equal to the weights composes the SIR draw which results in a new proposed posterior distribution. The mean and covariance values of the SIR-drawn parameters are calculated and a student's multivariate t-distribution is applied to regenerate parameter vectors of sample size equal to N_{init}. The new parameter distributions are then applied to exSSS to create new population trajectories which complete the steps.

This iterative process continues until a pre-specified entropy criterion is met. Entropy is a measure of uniformity about the sample weights with values ranging between 0 and 1. As the importance sample function closes in on the target distribution, the value of entropy will approach 1, which indicates a perfectly uniform distribution with each weight being equal to 1/N. Entropy was calculated as:

$$e = -\sum_{i=1}^{n} w_i \frac{\log\left(w_i\right)}{\log\left(N\right)} \tag{0.0}$$

The AIS continued until an entropy criterion of 0.92 was reached (point of convergence). Model testing demonstrated that entropy = 0.92 was a point where there was limited change in the posterior distributions. Once model convergence was reached, a final large SIR of 6,000 samples was drawn from the distribution of parameters that met the entropy criterion. The final large SIR sample of parameter vectors, the final posterior distributions, is then applied by exSSS to create a distribution of final trajectories with estimated biomasses and OFLs.

2.4 Response to STAR Panel Recommendations

There are no formal STAR panel recommendations that address the new applications of category 2 assessments to these stocks.

2.5 Base-Models, Uncertainty and Sensitivity Analyses

2.5.1 XDB-SRA assessments (Fishery-dependent indices only)

2.5.1.1 Brown Rockfish

Scope of the assessment: The post-STAR panel XDB-SRA base model for brown rockfish incorporates coastwide estimates of total removals (landings + discard). Landings north of Cape Mendocino are a small fraction (approximately 1%) of the cumulative coastwide historical landings (brown rockfish is uncommon in the northern region) and we have no trend indices for Oregon or Washington. We assume that trends north of Cape Mendocino do not differ from the southern portion of the population and we include landings from north of Mendocino to provide a basis for a coastwide OFL.

Stock status and biomass trends: For comparative purposes, we report nominal female spawning biomass (hereafter 'spawning biomass') as half total adult biomass. The model for brown rockfish suggests the stock is near target biomass (Table 43; Figure 55). The posterior distribution for spawning biomass in 2013, as a percentage of unfished biomass (aka "depletion"), has a median of 42%, with 2.5 and 97.5 percentiles of 22% and 77% of unfished biomass (Table 43). Median spawning biomass in 2013 is 727 mt, and median unfished spawning biomass was 1794 mt. Median spawning biomass declined rapidly during the 1970s and 1980s, but has shown an increasing trend since the mid-1990s (Table 44; Figure 55).

Yield estimates: The XDB-SRA base model estimates that median MSY for brown rockfish is 149 mt per year, and the fishing mortality rate in 2012 was 63% of F_{MSY}. The posterior medians for coastwide OFL in 2015 and 2016 were 166 and 162 mt, respectively (Table 43). These OFL estimates assume removals of 101.5 mt per year from 2013-2015 (Table 45).

Model Convergence: The SIR algorithm initially drew 500000 parameter vectors from the joint prior distribution, then resampled 15000 draws from the prior using likelihood weights to obtain the joint posterior distribution. Convergence of the SIR algorithm was evaluated by calculating the maximum resampling weight (0.001), which was well below the assumed convergence threshold (0.01).

Fit to indices of abundance: The indices used in the XDB-SRA model are 1) the onboard CPFV observer index for Central California (1988-2011), 2) a Southern California onboard CPFV observer index (1999-2011), 3) a RecFIN dockside CPFV observer index for Central California (1980-2003), and 4) a RecFIN dockside CPFV observer index for Southern California (1980-2003). Comparison of relative abundance time series, rescaled by the model-estimated catchability coefficients (i.e., in biomass units), suggests reasonable links between indices within the model (Figure 56). The model is better able to capture trends in the Central California time series, underestimating increases in abundance during the early 2000s apparent in the Southern California indices (Figure 57). For this reason, sensitivity analyses based on regional models were considered, but ultimately rejected in favor of a coastwide model. See "Sensitivity Analyses" (below).

Parameter estimates: All catchability coefficients were integrated over a diffuse prior to reduce model dimension (Table 45). Additive variance parameters were estimated for all four indices, the largest of which had a median of 0.8 (the southern California onboard CPFV observer index). The large amount of variance reflects the poor fit to this index, relative to the other indices. The posterior distributions for F_{MSY}/M shifted toward slightly larger values, and B_{MSY}/B_0 shifted only slightly but showed little support for values in the tails of the prior. Relative to the prior, the posterior distribution for delta in the year 2000 was much more precise, with a median of 0.70 ("depletion" = 0.30).

Comparison to Catch-Based Model (DB-SRA): Outputs from the DB-SRA model for brown rockfish are essentially prior predictive distributions from the XDB-SRA base model. Assuming constant catches of 101.5 mt per year, the median OFL estimates for 2015-16 from DB-SRA are 185 mt and 189 mt, respectively, compared to 166 mt and 162 mt from XDB-SRA (Table 43).

Sensitivity Analyses: Regional models for brown rockfish (north and south of Point Conception) were evaluated by the STAR Panel in response to the poor fit to abundance indices for southern California. The posterior distribution for F_{MSY}/M in the southern model favored unrealistically large values for a rockfish. However, this result is not unexpected when fitting a model with deterministic recruitment to a rapidly increasing abundance trend (possibly driven by recent strong recruitments). Given the unlikely differences in estimated productivity for this species between the two regions, the Panel recommended that the OFL be based on the coastwide model, and partitioned between the regions based on cumulative 1916-2012 removals by area. The panel requested that RecFIN dockside indices be developed for each region separately. Other sensitivity analyses considered by the panel included the effect of diffuse and informative priors on F_{MSY}/M and B_{MSY}/B_0, and model results based on fits to individual indices (Table 46).

2.5.1.2 China Rockfish

The STAR panel favored regional models for China rockfish over a coastwide model. This decision was based on improved fits to the indices, evidence of regional differences in biomass and exploitation trends, and plausible productivity parameters in both regional models.

China rockfish, north of 40° 10′ N lat.
Scope of the assessment: The post-STAR panel XDB-SRA base model for China rockfish (north of 40° 10′ N lat.) incorporates total removals (landings + discard) between approximately Cape Mendocino, CA and the U.S.-Canada border. Although often considered to have a northern distribution along the U.S. west coast, cumulative historical removals of China rockfish north of Cape Mendocino are less than one-third of the removals from central California (Figure 14). No trend information is currently available for waters off Washington. The model assumes trends in abundance off northern California and Oregon are representative of Washington.

Stock status and biomass trends: The model for northern China rockfish suggests the stock is below target biomass but above the MSST (Table 43; Figure 58). The posterior distribution for spawning biomass in 2013, as a percentage of unfished biomass (aka “depletion”), has a median of 37%, with 2.5 and 97.5 percentiles of 12% and 73% of unfished biomass (Table 43). Median spawning biomass in 2013 is 84 mt, and median unfished spawning biomass is 243 mt. Median spawning biomass has declined consistently since the 1980s (Table 47; Figure 58).

Yield estimates: The XDB-SRA base model estimates that median MSY for northern China rockfish is 9 mt per year, and the fishing mortality rate in 2012 was 215% of F_{MSY}. The posterior medians for OFL in 2015 and 2016 are both 7 mt, respectively (Table 43). These OFL estimates assume removals of 15.2 mt per year from 2013-2015 (Table 48).

Model Convergence: The SIR algorithm initially drew 300000 parameter vectors from the joint prior distribution, then resampled 15000 draws from the prior using likelihood weights to obtain the joint posterior distribution. Convergence of the SIR algorithm was evaluated by calculating the maximum resampling weight (0.0005), which was well below the assumed convergence threshold (0.01).

Fit to indices of abundance: The indices used in the XDB-SRA model are 1) RecFIN dockside CPFV observer index for Northern California and Oregon (1980-2003) and 2) an Oregon onboard CPFV observer index (2001-2012) (Figure 59). Comparison of relative abundance time series, rescaled by the model-estimated catchability coefficients (i.e., in biomass units), suggests reasonable links between indices within the model (Figure 60).

Parameter estimates: All catchability coefficients were integrated over a diffuse prior to reduce model dimension (Table 48). Additive variance parameters were estimated for both indices, although neither was large relative to the input variances (Figure 59). The posterior distributions showed little updating relative to the priors, with the exception of delta (in the year 2000). The post-model, pre-data distribution contained very little support for low biomass estimates (<30% of unfished) in 2000. The posterior distribution for delta in 2000 was similar, but slightly more precise, with a median of 0.46 ("depletion" = 0.64).

Comparison to Catch-Based Model (DB-SRA): Outputs from the DB-SRA model are essentially prior predictive distributions from the XDB-SRA base model. Assuming constant catches of 15.2 mt per year, the median OFL estimates for 2015-16 from DB-SRA are 7 mt and 7 mt, respectively, compared to 7 mt and 7 mt from XDB-SRA (Table 43).

Sensitivity Analyses: Preliminary analyses considered by the panel examined the effect of diffuse and informative priors on F_{MSY}/M and B_{MSY}/B_0, and changes in outputs based on fits to individual indices (Table 49). The effect of informed vs. diffuse productivity priors was minimal, with a 1% in depletion and 1 mt change in OFL (about 15%, given the small yields). The separate fits to the two indices produced a slightly larger difference in 2013 depletion (neither below the MSST), but both datasets estimated F_{2012}/F_{MSY} well over 1, suggesting that although the stock is not overfished, it is likely that overfishing is occurring.

China rockfish, south of 40°10′N lat.

Scope of the assessment: The post-STAR panel XDB-SRA base model for China rockfish (south of 40° 10′ N lat.) incorporates total removals (landings + discard) between approximately Cape Mendocino, CA and the U.S.-Mexico border, although few China rockfish have been landed south of Point Conception in recent decades (Figure 14). The assumption of an isolated stock remains untested (see Research Needs section).

Stock status and biomass trends: The model for central/southern China rockfish suggests the stock is above target biomass with high probability (Table 43; Figure 61). The posterior distribution for spawning biomass in 2013, as a percentage of unfished biomass (aka "depletion"), has a median of 66%, with 2.5 and 97.5 percentiles of 40% and 93% of unfished biomass (Table 43). Median spawning biomass in 2013 is 264 mt, and median unfished spawning biomass is 405 mt. Median spawning biomass has increased steadily since the late 1990s (Table 50; Figure 61).

Yield estimates: The XDB-SRA base model estimates that median MSY for central/southern China rockfish is 32 mt per year, and the fishing mortality rate in 2012 was 27% of F_{MSY}. The posterior medians for OFL in 2015 and 2016 are 55 and 53 mt, respectively (Table 43). These OFL estimates assume removals of 40 mt per year from 2013-2015 (Table 51).

Model Convergence: The AIS algorithm was set to an initial sample size of 7500, a working sample of 3000 (with mixture reduction to 500 points at each step), and a final AIS sample of 15000. The model converged to an acceptable entropy score (0.96) and maximum importance weight (0.004).

Fit to indices of abundance: The indices used in the XDB-SRA model for central/southern China rockfish are 1) RecFIN dockside CPFV observer index for central and southern California (1980-2003) and 2) a central California onboard CPFV observer index (1988-2011). Comparison of relative abundance time series, rescaled by the model-estimated catchability coefficients (i.e., in biomass units), suggests reasonable links between indices within the model (Figure 62).

Parameter estimates: All catchability coefficients were integrated over a diffuse prior to reduce model dimension (Table 51). Additive variance parameters were estimated for both indices, although neither was large relative to the input variances (Figure 62). The posterior distributions for F_{MSY}/M and B_{MSY}/B_0 were both shifted to the right of their respective prior densities. Delta (in the year 2000) was slightly updated by the post-model, pre-data distribution, but the continued shift in the posterior distribution suggests the data support a less-depleted stock, with a median of 0.50 (Figure 63).

Comparison to Catch-Based Model (DB-SRA): Outputs from the DB-SRA model are essentially prior predictive distributions from the XDB-SRA base model. Assuming constant catches of 16.1 mt per year, the median OFL estimates for 2015-16 from DB-SRA are both 20 mt, compared to 55 mt and 53 mt from XDB-SRA (Table 43). The difference between the two models is the higher productivity of XDB-SRA's updated posterior parameter distributions, relative to the prior predictive distributions.

Sensitivity Analyses: Diffuse priors on F_{MSY}/M and B_{MSY}/B_0 resulted in a smaller, more productive stock relative to the original DB-SRA priors. Separate fits to the two indices produced a 14% difference in median 2013 depletion, but both datasets estimated F_{2012}/F_{MSY} well below 1 and 2013 biomass above target (Table 52).

2.5.1.3 Copper rockfish

Copper rockfish, north of 34°27′ N lat.

Scope of the assessment: The post-STAR panel XDB-SRA base model for central/northern copper rockfish incorporates total removals (landings + discard) between Point Conception and the U.S.-Canada border. No trend information is currently available for waters off Washington. The model assumes trends in abundance off central/northern California and Oregon are representative of Washington.

Stock status and biomass trends: The model for central/northern copper rockfish suggests the stock is near target biomass (Table 43; Figure 64). The posterior distribution for spawning biomass in 2013, as a percentage of unfished biomass (aka "depletion"), has a median of 48%, with 2.5 and 97.5 percentiles of 26% and 85% of unfished biomass (Table 43). Median spawning biomass in 2013 is 795 mt, and median unfished spawning biomass is 1704 mt. According to the model, median spawning biomass has been increasing steadily since the late-1990s (Table 53, Figure 64).

Yield estimates: The XDB-SRA base model estimates that median MSY for central/northern copper rockfish is 114 mt per year, and the fishing mortality rate in 2012 is 34% of F_{MSY}. The posterior medians for OFLs north of 34°27' N lat. in 2015 and 2016 are 145 and 141 mt, respectively (Table 43). These OFL estimates assume removals of 38.2 mt per year from 2013-2015 (Table 54).

Model Convergence: The SIR algorithm initially drew 300000 parameter vectors from the joint prior distribution, then resampled 15000 draws from the prior using likelihood weights to obtain the joint posterior distribution. Convergence of the SIR algorithm was evaluated by calculating the maximum resampling weight (0.001), which was well below the assumed convergence threshold (0.01).

Fit to indices of abundance: The indices used in the XDB-SRA model are 1) the onboard CPFV observer index for Central California (1988-2011), 2) a RecFIN dockside CPFV observer index for Central California and Oregon (1980-2003), and 3) an onboard CPFV observer index for Oregon (2001-2012). Comparison of relative abundance time series, rescaled by the model-estimated catchability coefficients (i.e., in biomass units), suggests reasonable links between indices within the model (Figure 65). The model is better able to capture trends in the two onboard observer time series, with the dockside RecFIN index showing a decline after 2000 that is not captured by the model (Figure 66, index 2). This lack of fit is reflected in the slightly higher additive variance estimate for the dockside index.

Parameter estimates: All catchability coefficients were integrated over a diffuse prior to reduce model dimension (Table 54). The posterior distribution for F_{MSY}/M shifted toward slightly larger values, but the distributions for M and B_{MSY}/B_0 shifted only slightly (Figure 66). Relative to the prior, the posterior distribution for delta in the year 2000 was much more precise, with a median of 0.72 ("depletion" = 0.28). The posterior updating of delta is data-driven, as there is little change between the prior and the post-model, pre-data distribution.

Comparison to Catch-Based Model (DB-SRA): Assuming constant catches of 38.2 mt per year, the median OFL estimates for 2015-16 from DB-SRA are 100 mt and 97 mt, respectively, compared to 145 mt and 141 mt from XDB-SRA (Table 43).

Sensitivity Analyses: Regional models for central/northern copper rockfish were developed during the STAR Panel in response to the poor fit to abundance indices for southern California. Sensitivity analyses based on the original coastwide model that were presented to the Panel are provided here for completeness (Table 55).

Copper rockfish, south of 34° 27′ N lat.

Scope of the assessment: The post-STAR panel XDB-SRA base model for southern copper rockfish (south of 34° 27′ N lat.) incorporates total removals (landings + discard) between approximately the U.S.-Mexico border and Point Conception.

Stock status and biomass trends: The model for southern copper rockfish suggests the stock is above target biomass with high probability (Table 43; Figure 67). The posterior distribution for spawning biomass in 2013, as a percentage of unfished biomass (aka "depletion"), has a median of 76%, with 2.5 and 97.5 percentiles of 43% and 99% of unfished biomass (Table 43). Median spawning biomass in 2013 is 699 mt, and median unfished spawning biomass was 942 mt. According to the model, median spawning biomass has increased steadily since the late 1980s (Table 56, Figure 67).

Yield estimates: The XDB-SRA base model estimates that median MSY for southern copper rockfish is 84 mt per year, and the fishing mortality rate in 2012 was 32% of F_{MSY}. The posterior medians for OFL in 2015 and 2016 were both 167 and 154 mt, respectively (Table 43). These OFL estimates assume removals of 40 mt per year from 2013-2015 (Table 57).

Model Convergence: The AIS algorithm was set to an initial sample size of 7500, a working sample of 3000 (with mixture reduction to 500 points at each step), and a final AIS sample of 15000. The model converged to an acceptable entropy score (0.95) and maximum importance weight (0.002).

Fit to indices of abundance: The indices used in the XDB-SRA model for southern copper rockfish are 1) a southern California onboard CPFV observer index (1999-2011) and 2) RecFIN dockside CPFV observer index for southern California (1980-2003) (Figure 68). Similar to brown rockfish, the deterministic model had difficulty matching the rate of increase suggested by the onboard observer index. Comparison of relative abundance time series, rescaled by the model-estimated catchability coefficients (i.e., in biomass units), suggests reasonable links between indices within the model (Figure 69).

Parameter estimates: All catchability coefficients were integrated over a diffuse prior to reduce model dimension (Table 57). Additive variance was estimated for both indices, but was close to zero for the RecFIN index (Figure 68). The posterior distributions for F_{MSY}/M and B_{MSY}/B_0, but not M, were shifted to the right of their respective prior densities. Delta (in the year 2000) was only slightly updated by the model, but the continued shift in the posterior distribution suggests the data support a less-depleted stock, with a median of 0.43.

Comparison to Catch-Based Model (DB-SRA): Outputs from the DB-SRA model are essentially prior predictive distributions from the XDB-SRA base model. Assuming constant catches of 16.1 mt per year, the median OFL estimates for 2015 and 2016 from DB-SRA are 52 and 46 mt, respectively, compared to 167 and 154 mt, respectively from XDB-SRA (Table 43). The difference between the two models is the higher productivity of XDB-SRA's updated posterior parameter distributions, relative to the prior predictive distributions.

2.5.2 ExSSS assessments (Fishery-independent indices only)

2.5.2.1 Sharpchin rockfish

Model: The base case model was structured as a coastwide model with two triennial survey time series (pre- and post- 1995) and one annual survey time series. The model fits all points in each of the three fishery-independent abundance indices (Figure 70) with no additional variance added to the indices (early Triennial: 0.00; late Triennial: 0.00; NWFSC: 0.00; Table 58). The median posterior value of q for both triennial surveys were 0.53 and 1.35 for the early and late time periods, respectively, but the NWFSC survey was almost 7, an unlikely number for a rockfish (Table 58; Figure 71). Sensitivity to including that survey is reported below. The AIS entropy criterion quickly met the convergence criterion (Figure 72). Priors for both the steepness and stock status were updated (slightly downward and upward, respectively) by inclusion of the index data (Figure 73). Pairs plots for all parameters are provide in Figure 74 and show low correlation or bounding in the parameter draws.

Derived model outputs: Model outputs for stock status and spawning biomass are reported in Table 59. Estimates of spawning biomass (Figure 75) and stock status (Figure 76) were different for the MLE and AIS exSSS estimates. The median of the posterior for stock status was estimated at 68%, well above target the reference level (Table 59; Figure 77). The peak of the posterior estimates of F_{MSY}/M is >1 (Figure 78), not surprising for high steepness values (posterior median = 0.77). OFLs for 2015 and 2016 are provided in Figure 79. Estimates of population scale (biomass) and status for the catch-only SSS model were lower and less optimistic with lower levels of uncertainty than the exSSS model (Table 59; Figure 80).

Sensitivities: Model results demonstrated sensitivity to the inclusion of abundance indices (Table 60). Using only the short Triennial late survey produced smaller biomasses and a more depleted stock, though still well above the target level. The NWFSC survey by itself was uninformative and would not produce a converged model. Taking the NWFSC survey out to avoid the questionably high q, but leaving both Triennial surveys in produced a smaller biomass and subsequently smaller OFLs, with a slightly more depleted stock. The use of the Hamel M prior produced a slightly less depleted stock and higher OFLs, while use of the old rockfish steepness prior produced a slightly more depleted stock and lower OFLs.

Steepness profile: Derived outputs were sensitivity to the steepness value (Figure 81). Higher steepness values generally corresponded to increased initial and current spawning biomass, the latter at a higher right, causing stock status to increase towards 1. Comparison to the prior values of F_{MSY}/M and B_{MSY}/B_0 used in XDB-SRA demonstrate that the prior and estimated h values from exSSS assume a much higher productivity for sharpchin rockfish than would be assumed in XDB-SRA (Figure 82).

2.5.2.2 Yellowtail Rockfish (North of 40° 10' N lat.)

Model: The base case model was structured as a model assessing the portion of the population north of 40°10' N lat. with a combined triennial survey time series and one annual survey time series. All fishery-dependent (Hake bycatch, commercial CPUE and recreational based indices) were not included as recommended by the STAR panel. The model fits all points in each of the two fishery-independent abundance indices (Figure 83) with higher additional variance added to the triennial survey (Table 58; Figure 84). The median posterior value of q for the triennial and annual surveys were 0.54 (very similar to sharpchin rockfish) and 0.22 (Table 58; Figure 85). The AIS entropy criterion quickly met the convergence criterion (Figure 72). Priors for both the steepness and stock status were updated (slightly downward and upward, respectively) by inclusion of the index data (Figure 86). Pairs plots for all parameters are provide in Figure 87 and show low correlation or bounding in the parameter draws.

Derived model outputs: Model outputs for stock status and spawning biomass are reported in Table 59. Estimates of spawning biomass (Figure 88) and stock status (Figure 89) were notably different for the MLE and AIS exSSS estimates, with the MLE showing higher biomass and a less depletion stock. The median of the posterior for stock status was estimated at 67%, well above target the reference level (Table 59; Figure 90). Current estimates of spawning biomass are comparable to past assessments (Figure 91). The peak of the posterior estimates of F_{MSY}/M is >1 (Figure 92), not surprising for high steepness values (posterior median = 0.79). OFLs for 2015 and 2016 are provided in Figure 93. Estimates of population scale (biomass) and status for the catch-only SSS model were lower and less optimistic with lower levels of uncertainty in spawning biomass than the exSSS model (Table 59; Figure 94).

Sensitivities: Model results demonstrated sensitivity to the inclusion of abundance indices (Table 61). Removing the annual survey and using only the triennial surveys, combined or separated, produced smaller biomasses and a more depleted stock, though still well above the target level in all cases. The annual NWFSC survey by itself indicated much higher biomasses and a high measure of stock status. The use of the Hamel M prior produced a slightly less depleted stock and higher OFLs, while use of the old rockfish steepness prior produced a slightly more depleted stock and lower OFLs.

Steepness profile: Derived outputs were moderately sensitivity to the assumed steepness value (Figure 95). Only the lower steepness values produced noticeable changes in biomass and stock status. Comparison to the prior values of F_{MSY}/M and B_{MSY}/B_0 used in XDB-SRA demonstrate that the prior and estimated h values from exSSS assume a much higher productivity for yellowtail rockfish than would be assumed in XDB-SRA (Figure 96).

2.5.2.3 English Sole

Model: The base case model was structured as a coastwide model with two triennial survey time series (pre- and post- 1995) and one annual survey time series. The model fits all points in each of the three fishery-independent abundance indices (Figure 97) with higher additional variance added to the NWFSC annual survey (Table 58; Figure 98). The median posterior value of q for each survey was >1, with the triennial survey being higher than the NWFSC annual survey (Table 58; Figure 99). Values of q > 1 are not unexpected for flatfishes (Bryan et al. in review). The AIS entropy criterion quickly met the convergence criterion (Figure 72). Priors for both the steepness and stock status were updated (slightly upward and downward, respectively) by inclusion of the index data (Figure 100). Pairs plots for all parameters are provide in Figure 101 and show low correlation and only slight bounding in the parameter draws.

Derived model outputs: Model outputs for stock status and spawning biomass are reported in Table 59. Estimates of spawning biomass (Figure 102) were different than that estimated from the MLE (higher relative to the AIS values), but stock status (Figure 103) was similar between MLE and AIS exSSS estimates. The median of the posterior for stock status was estimated at 88%, well above target the reference level (Table 59; Figure 104). The exSSS model is comparable to the 2007 English sole assessment, with the uncertainty level encompassing the probable biomass and depletion levels of the former assessment (Figure 105). The peak of the posterior estimates of F_{MSY}/M is >>1 (Figure 106). OFLs for 2015 and 2016 are provided in Figure 107. Estimates of population scale (biomass) and status for the catch-only SSS model are very similar to the exSSS model, with more uncertainty in the SSS model (Table 59; Figure 108).
Sensitivities: Model results were robust to most sensitivity runs explored (Table 62). Stock status was most sensitive when the model used the late triennial time series only. The scale of the population biomass was most sensitive to when only using either the late triennial or the NWFSC annual survey. The use of the Hamel M prior produced lower biomass and OFL estimates.

Steepness profile: Derived outputs were sensitivity to the steepness value (Figure 109). Higher steepness values generally corresponded to decreased initial and current spawning biomass, though depletion was robust to all but the lowest steepness values. Comparison to the prior values of F_{MSY}/M and B_{MSY}/B_0 used in XDB-SRA demonstrate that the prior and estimated h values from exSSS assume a higher productivity for English sole than would be assumed in XDB-SRA (Figure 110).

2.5.2.4 Rex Sole

Model: The base case model was structured as a coastwide model with two triennial survey time series (pre- and post- 1995) and one annual survey time series. The model fits all points in each of the three fishery-independent abundance indices (Figure 111) with higher additional variance added to the early triennial survey (Table 58; Figure 112). The median posterior value of q for each survey was >1, with the triennial survey being higher than the NWFSC annual survey (Table 58; Figure 113). Values of q > 1 are not unexpected for flatfishes (Bryan et al. in review; STAR Panel report of 2013 petrale sole), though such high values are questionable. The AIS entropy criterion quickly met the convergence criterion (Figure 72). Priors for both the steepness and stock status were updated (slightly upward and downward, respectively) by inclusion of the index data (Figure 114). Pairs plots for all parameters are provide in Figure 115 and show low correlation and only slight bounding in the parameter draws.

Derived model outputs: Model outputs for stock status and spawning biomass are reported in Table 59. Estimates of spawning biomass (Figure 116) were different than that estimated from the MLE (higher relative to the AIS values), but stock status (Figure 117) was similar between MLE and AIS exSSS estimates. The median of the posterior for stock status was estimated at 80%, well above target the reference level (Table 59; Figure 118). The peak of the posterior estimates of F_{MSY}/M is >>1 (Figure 119). OFLs for 2015 and 2016 are provided in Figure 120. Estimates of population scale (biomass) and status for the catch-only SSS model are very similar to the exSSS model, with more uncertainty in the SSS model (Table 59; Figure 121).
Sensitivities: Model results were sensitive to many of the sensitivity runs explored (Table 63). Stock status was least sensitive, only showing sensitivity when the model used the late triennial time series only. The scale of the population biomass was very sensitive to most explored model configurations.

Steepness profile: Derived outputs were sensitivity to the steepness value (Figure 122). Higher steepness values generally corresponded to changing initial and current spawning biomass, though depletion was robust to most steepness values. Comparison to the prior values of F_{MSY}/M and B_{MSY}/B_0 used in XDB-SRA demonstrate that the prior and estimated h values from exSSS assume a higher productivity for English sole than would be assumed in XDB-SRA (Figure 123).

The scale of the population proved to be highly uncertain, both in absolute measures and relative sensitivities, making the results of these models uninformative to scale, and thus to resultant catch estimates (i.e., OFLs).

2.5.3 Status-Only Assessment

2.5.3.1 Stripetail Rockfish

Assessments for stripetail rockfish immediately proved to be highly uninformative as to the scale of the population. Instead of abandoning this assessment altogether, the STAT explored stock status across the uncertainty in population scale. Both XDB-SRA and exSSS were used in the explorations. For the exSSS model, profiles over the initial recruitment (R_0) were considered for lnR_0 values from 6 to 20 (Figure 124). Stock status (depletion) remained above the target for values of lnR_0 >7. Values below that level had –log likelihood values significantly different from the lowest value. It was near virgin levels for values of lnR_0 >10. The results strongly indicate that the index data inform the status to be well above the target level, though the scale of the population is greatly unknown.

An analogous profile over alternative population sizes was done using XDB-SRA, in this case scanning over alternative values of the catchability coefficient (q) for the two trawl surveys (both were assumed to have the same q). The surveys were originally designed to have a catchability coefficient of approximately 1 (ln(q)=0). The posterior distributions from the XDB-SRA model reflect the priors, and are not significantly updated by the data. Table 64 shows the results for values of ln(q) ranging from -1 to 1.5. Corresponding estimates of relative abundances (a.k.a. depletions) were near unfished levels over most of this range, and only begin to decline as q approaches implausibly high values (ln(q)=1.5; q=4.5). Current fishing intensity is estimated to be negligibly small in all cases. The STAR Panel was unwilling to accept a prior probability distribution of q, so no formal quantitative estimates of productivity are presented. On a very approximate scale, MSY appears to be on the order of a few hundred tons, but because relative abundance is high, current OFL estimates approach 1000 tons.

3 Harvest Projections and Decision Tables

Forecasts for each stock are based on a 12-year outlook predicated one of two control rules: 1) constant catch based on the average of the last three years or landings and 2) catch based on the P* OFL buffer and the “40-10” ABC control rule. The latter has three catch scenarios based on the forecasted results of the three states of nature. These states of nature capture different states in depletion by taking the median value of starting depletion and resultant median forecasted catch under control rule 2 above and the base case model for the following portions of the posterior depletion distribution: 1) bottom quartile of starting depletion values, 2) interquartile of the starting depletion, and 3) upper quartile of the starting depletion. Thus 25% of the distribution is in each of the lower and upper states of nature, with 50% contained in the middle state. A total of three models were therefore run with the three different catch scenarios based on control rule #2, then each state of nature (posterior density quartiles) was summarized by the median value of the draws contained in that state of nature. Each forecast assumes full attainment of the prescribed catch and no implementation error.

Decision tables for the nearshore rockfish stock assessments are given in Table 65 through Table 69. Results for China rockfish (north of 40°10' N lat.) and brown rockfish (coastwide) include the probability that spawning biomass is below the minimum stock size threshold (MSST) of $0.25B_0$. This information is not presented for the other stocks, because the probabilities of becoming overfished were less than 1% for all three catch scenarios under the base-case model.

Results for the shelf-slope fishery-independent stock assessments area provided in Table 70 through Table 73. The average catch scenarios increase the stock biomass, and thus status, of all stocks in all states of nature. The high catch scenarios drop stock status below the target reference point in the base depletion state of nature by the end of the 12 year forecast in all four stocks. The rockfishes also drop below the limit reference point in the low depletion state of nature under the high catch scenario.

4 Research Needs

The following list contains research recommendations to further improve the application of catch and index only stock assessments:

1. Continued research on the uncertainty in the catch histories of all groundfishes. Catch is a critical component of these and all stock assessments, especially when attempting to define population scale. Reconstructions of historical catches are still needed for certain areas, time periods, and fisheries. Currently, reconstructed catches are available for California's commercial and recreational fisheries extending back to 1916 and 1928, respectively (Ralston et al. 2010). Oregon has completed a reconstruction for its commercial catch since 1876 (V. Gertseva, NMFS; pers. comm.), but recreational catch prior to 1980 is assumed to be zero in this analysis. Recreational catch in Washington was reconstructed to 1975 for these assessments, and interpolated back to 1960. A thorough reconstruction of historical commercial catches (prior to 1981) is urgently needed for Washington. Estimates of uncertainty in historical catch reconstructions are needed for all states. Reconstructed catches tend to be most precise for common species, and progressively less precise as species become uncommon. Because data-poor and data-moderate assessments focus on the less common species, quantification of the precision of catch reconstructions is especially important to these assessments.
2. Model selection criteria for the GLMM model, including insight when to consider the ECE models. The lognormal model frequently showed different time series behavior than the gamma and ECE models, the latter of which usually gave consistent results. The ability to determine whether lognormal or gamma is most appropriate, as well as understanding when the ECE approach should be considered will help formulate the best index treatment.
3. Further consideration as to when it is appropriate to split or maintain the full time series for the Triennial survey. While this proved of little sensitivity in these examples, it could be important in some instances.
4. The NWFSC survey showed poor behavior or limited information for all stocks. Understanding why this may be (including the residual patterns) will help diagnose its use as a data input for catch and index only models.
5. Further understanding of reasonable or probable catchability (q) values will enhance the interpretation of scale, a generally weakly informed output of these catch and index-only models that are dependent on trawl surveys. We already have an extensive collection of estimated q values from data-rich assessments, assuring feasibility. Priors on q would be useful in several respects:

a. Priors could be used to link the time series of triennial and NWFSC survey abundance estimates, greatly enhancing their information content.
b. For lightly-fished species such as stripetail rockfish, a prior distribution of q would allow quantitative estimation of ABC and OFL so that management can make informed decisions regarding fishery development and conservation. Values of ABC and OFL should not require experience from an intense historical fishery to be quantitatively acceptable.
c. Improved understanding of multispecies patterns in survey q could be useful for evaluating survey performance and diagnosis (see recommendation #4).

6. More direct attempts to compare XDB-SRA and exSSS models to understand why they may give different results. Reconciling the use of different productivity assumptions (i.e., priors) in XDB-SRA and exSSS is a major part of this work. Progress was made during the STAR panel, but much more work is needed.
7. Given the success of the efforts reported herein, more attempts at data-moderate assessment are anticipated. Further development of exSSS and XDB-SRA capabilities and speed of execution would be beneficial. One useful area of development is quantitative treatment of historical catch imprecision (see recommendation #1). Further technical details are not described here.
8. Single-species stock assessment models are still unable to address systematic changes in productivity due to external factors such as inter-species relationships and low-frequency aspects of climate change. Relatively simple data-moderate models may provide tractable linkages to ecosystem models, and are relatively easy to modify to reflect ecosystem forces.
9. Exploration of trans-boundary assessments with Canada should be initiated, and would benefit all parties. This also requires development of data inputs including historical catch reconstructions. Due to their transparency, data-moderate assessments may play an especially useful role in promoting trans-boundary fishery science.

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7 Tables

7.1 Model data and inputs

7.1.1 Life histories

Table 1. Life history values for each stock used in either the xDB-SRA or exSSS models. A_{MAX}: longevity; L_{MAX}: maximum length; M: natural mortality rate; L_1: length at age 1; L_∞: asymptotic length; k: von Bertalanffy growth coefficient; CV_x: CV at L_1 or L_∞; a,b: weight-length parameters; $L_{50\%}$: length at 50% maturity; slope: slope of maturity curve; A_{MAT}: age at maturity.

						Growth										Weight (g) -length (cm) relationship				Maturity		
						Female					Male					Female		Male		Length		Age
Scientific name	Common Name	Species code	A_{MAX}	L_{MAX}	M	L_1	L_∞	k	CV_1	CV_∞	L_1	L_∞	k	CV_1	CV_∞	a	b	a	b	$L_{50\%}$	slope	A_{MAT}
Sebastes auriculatus	Brown rockfish	BRWN	34	56	0.14	11.29	51.40	0.16	0.10	0.10	11.29	51.40	0.16	0.10	0.10	1.37E-05	3.03	9.59E-06	3.15	26	-2.29	4
Sebastes nebulosus	China rockfish	CHNA	79	45	0.06	5.32	37.30	0.19	0.10	0.10	7.79	37.50	0.19	0.10	0.10	6.64E-06	3.21	8.79E-06	3.15	27	-5.53	5
Sebastes caurinus	Copper rockfish	COPP	50	66	0.09	14.48	57.20	0.13	0.10	0.10	9.42	51.70	0.22	0.10	0.10	9.39E-06	3.18	1.36E-05	3.08	34	-1.33	6
Sebastes zacentrus	Sharpchin rockfish	SHRP	58	49	0.08	8.25	33.21	0.17	0.10	0.10	8.23	26.98	0.20	0.10	0.10	8.27E-06	3.16	9.10E-06	3.13	22	-5.01	6
Sebastes saxicola	Stripetail rockfish	STRK	38	41	0.12	9.47	33.05	0.06	0.10	0.10	10.37	17.38	0.19	0.10	0.10	1.68E-05	2.95	2.98E-05	2.72	17	-2.30	4
Sebastes flavidus	Yellowtail rockfish (N)	YTRK_N	64	66	0.11	13.44	52.21	0.17	0.10	0.10	19.04	47.57	0.19	0.10	0.10	1.32E-05	3.03	1.24E-05	3.06	37	-0.47	10
Parophrys vetulus	English sole	ENGL	23	61	0.26	17.34	40.56	0.36	0.10	0.10	17.34	23.98	0.48	0.18	0.18	8.21E-06	3.02	1.04E-05	2.94	31	-0.61	4
Glyptocephalus zachirus	Rex sole	REX	29	61	0.20	13.45	41.82	0.39	0.10	0.10	13.45	41.82	0.39	0.10	0.10	3.02E-06	3.21	2.67E-06	3.25	35	-0.39	4

Sources: Washington 1978; Hoenig 1983; Lea et al. 1999; Shaw 1999; Love et al. 2002; Abookire 2005; Stewart 2007; Dick and MacCall 2010; Love et al. 2011; NWFSC trawl survey; NWFSC hook and line survey (M. Head, pers. comm.).

7.1.2 Removals

Table 2. Sources of removal data used in the data-moderate assessments.

Source Name	Time Period	Spatial Coverage
PacFIN	1981-2012	Cape Mendocino – Canadian border
CALCOM	1969-2012	California (1969-1980); Mexican border – Cape Mendocino (1981-2012)
RecFIN	1980-2012	Mexican border – OR/WA border
NORPAC	1990-2012	Cape Mendocino – Canadian border
Rogers (2003)	1966-1976	Pt. Conception – Canadian border
California Commercial Catch Reconstruction	1916-1968	California
California Recreational Catch Reconstruction	1928-1979	California
Oregon Commercial Catch Reconstruction	1892-1980	Oregon
Stewart (2007; English sole assessment)	1876-2006	Mexican border – Canadian border
Tagart (1985)	1963-1980	Washington
PMFC Data Series	1956-1980	Washington
Pacific Fisherman Yearbooks	1942-1955	Washington
Wallace and Lai (2005; Yellowtail rockfish assessment)	1967-2004	Cape Mendocino – Canadian border
CDFG Fish Bulletin #74	1916-1930	California
WA Recreational	1967, 1975-2012	Washington

Table 3. Removals (mt) of brown rockfish (*Sebastes auriculatus*) by year and region.

Year	Southern California	Central California	No. CA / OR / WA	Total	Year	Southern California	Central California	No. CA / OR / WA	Total
1916	0.02	9.18	0.00	9.20	1966	24.63	108.24	3.37	136.25
1917	0.03	14.26	0.00	14.30	1967	36.35	108.90	5.05	150.30
1918	0.03	16.69	0.00	16.72	1968	45.74	107.70	2.91	156.35
1919	0.02	11.61	0.00	11.63	1969	19.17	105.47	2.29	126.93
1920	0.02	11.84	0.00	11.86	1970	28.08	129.11	4.27	161.46
1921	0.02	9.78	0.00	9.79	1971	28.29	128.55	4.32	161.16
1922	0.02	8.41	0.00	8.42	1972	38.41	172.05	2.28	212.74
1923	0.02	9.08	0.00	9.11	1973	45.04	262.07	3.29	310.41
1924	0.03	5.23	0.00	5.25	1974	59.77	297.96	2.24	359.97
1925	0.03	7.53	0.00	7.56	1975	67.91	244.70	1.13	313.74
1926	0.04	9.58	0.00	9.62	1976	51.88	279.30	3.27	334.44
1927	0.03	4.25	0.00	4.28	1977	46.83	237.85	0.12	284.80
1928	0.05	5.69	0.00	5.75	1978	45.44	157.03	0.24	202.71
1929	0.08	5.33	0.02	5.42	1979	61.98	134.08	0.21	196.28
1930	0.10	10.35	0.02	10.47	1980	105.76	306.36	0.68	412.80
1931	0.15	13.63	0.03	13.81	1981	44.94	93.45	2.77	141.17
1932	0.13	14.18	0.03	14.33	1982	75.85	166.35	18.19	260.39
1933	0.18	15.56	0.04	15.78	1983	41.89	96.68	1.04	139.61
1934	0.18	11.02	0.04	11.24	1984	84.12	152.17	0.85	237.14
1935	0.20	14.20	0.04	14.45	1985	89.20	126.71	1.68	217.60
1936	0.20	14.76	0.04	15.01	1986	94.06	166.79	6.25	267.10
1937	0.19	16.76	0.06	17.02	1987	80.78	108.61	0.88	190.27
1938	0.55	17.70	0.07	18.32	1988	70.86	244.73	3.49	319.08
1939	1.06	19.00	0.07	20.14	1989	53.79	139.75	19.77	213.30
1940	0.42	21.81	0.08	22.31	1990	42.76	125.24	5.09	173.08
1941	0.55	21.43	0.07	22.05	1991	30.11	139.36	0.92	170.39
1942	0.08	6.58	0.04	6.70	1992	16.58	124.63	0.85	142.07
1943	0.10	8.59	0.05	8.74	1993	4.08	132.52	1.22	137.82
1944	0.08	5.36	0.15	5.59	1994	16.36	59.48	0.27	76.11
1945	0.11	11.75	0.37	12.23	1995	13.83	62.26	0.49	76.58
1946	0.19	22.47	0.34	23.00	1996	15.24	91.09	0.50	106.84
1947	0.76	13.18	0.10	14.04	1997	11.67	141.42	1.19	154.28
1948	1.39	20.94	0.19	22.52	1998	3.23	92.98	2.11	98.32
1949	2.04	27.62	0.15	29.81	1999	9.71	114.55	1.51	125.77
1950	2.36	27.75	0.13	30.24	2000	7.29	93.37	0.71	101.36
1951	2.15	43.69	0.23	46.07	2001	10.24	138.54	2.62	151.41
1952	3.00	43.44	0.20	46.64	2002	11.81	80.03	2.58	94.42
1953	2.79	34.16	0.17	37.12	2003	13.85	153.53	1.91	169.29
1954	7.57	43.16	0.13	50.86	2004	7.64	49.71	0.83	58.17
1955	12.64	86.38	0.17	99.19	2005	14.78	84.43	1.20	100.40
1956	14.22	91.89	0.17	106.28	2006	9.04	78.65	1.45	89.15
1957	11.86	96.55	0.23	108.64	2007	7.99	67.11	1.04	76.14
1958	11.02	118.11	0.22	129.36	2008	7.70	63.65	1.23	72.58
1959	8.08	82.74	0.15	90.97	2009	7.16	77.00	0.71	84.87
1960	14.12	92.12	0.10	106.34	2010	9.77	86.10	1.10	96.97
1961	21.54	63.64	0.09	85.27	2011	21.64	90.45	0.60	112.69
1962	12.66	79.47	0.05	92.18	2012	15.10	78.81	0.80	94.71
1963	15.25	101.05	0.13	116.42	***2013***				***101.45***
1964	10.73	83.35	0.16	94.24	***2014***				***101.45***
1965	17.00	102.28	0.32	119.61	***2015***				***101.45***

Table 4. Removals (mt) of brown rockfish (*Sebastes auriculatus*) by year and data source.

Year	RecFIN	CA Recreational Reconstruction	CALCOM	CA Commercial Reconstruction	PacFIN	OR Commercial Reconstruction	Foreign Fisheries	Commercial Discard	Total
1916				8.71				0.49	9.20
1917				13.53				0.76	14.30
1918				15.83				0.89	16.72
1919				11.01				0.62	11.63
1920				11.23				0.63	11.86
1921				9.27				0.52	9.79
1922				7.97				0.45	8.42
1923				8.62				0.49	9.11
1924				4.97				0.28	5.25
1925				7.16				0.40	7.56
1926				9.11				0.51	9.62
1927				4.05				0.23	4.28
1928		1.12		4.38				0.25	5.75
1929		2.23		3.02				0.17	5.42
1930		2.58		7.46				0.42	10.47
1931		3.45		9.81				0.55	13.81
1932		4.31		9.49				0.53	14.33
1933		5.17		10.04				0.57	15.78
1934		6.03		4.94				0.28	11.24
1935		6.89		7.15				0.40	14.45
1936		7.73		6.89		0.00		0.39	15.01
1937		9.11		7.47		0.01		0.42	17.02
1938		9.03		8.78		0.01		0.50	18.32
1939		7.92		11.56		0.01		0.65	20.14
1940		11.21		10.49		0.02		0.59	22.31
1941		10.36		11.05		0.01		0.62	22.05
1942		5.51		1.12		0.01		0.06	6.70
1943		5.27		3.28		0.01		0.19	8.74
1944		4.32		1.18		0.02		0.07	5.59
1945		5.76		6.10		0.02		0.34	12.23
1946		9.92		12.35		0.02		0.70	23.00
1947		8.31		5.41		0.01		0.31	14.04
1948		16.77		5.42		0.02		0.31	22.52
1949		21.66		7.70		0.02		0.43	29.81
1950		26.56		3.48		0.01		0.20	30.24
1951		31.79		13.51		0.01		0.76	46.07
1952		28.10		17.54		0.01		0.99	46.64
1953		24.70		11.76		0.00		0.66	37.12
1954		34.30		15.67		0.00		0.88	50.86
1955		45.04		51.26		0.01		2.89	99.19
1956		48.33		54.85		0.00		3.09	106.28
1957		40.90		64.12		0.01		3.61	108.64
1958		68.54		57.58		0.00		3.24	129.36
1959		50.72		38.10		0.00		2.15	90.97
1960		42.44		60.49		0.00		3.41	106.34
1961		32.51		49.93		0.01		2.81	85.27
1962		37.76		51.51		0.00		2.90	92.18
1963		47.28		65.45		0.01		3.69	116.42
1964		40.38		50.98		0.00		2.87	94.24
1965		60.48		55.96		0.02		3.15	119.61

Table 4 (Continued). Removals (mt) of brown rockfish (*Sebastes auriculatus*) by year and data source.

Year	RecFIN	CA Recreational Reconstruction	CALCOM	CA Commercial Reconstruction	PacFIN	OR Commercial Reconstruction	Foreign Fisheries	Commercial Discard	Total
1966		74.86		52.11		0.01	6.00	3.27	136.25
1967		75.32		59.96		0.03	11.00	4.00	150.30
1968		79.65		68.58		0.03	4.00	4.09	156.35
1969		76.69	45.51			0.05	2.00	2.68	126.93
1970		98.96	55.14			0.02	4.00	3.33	161.46
1971		88.74	64.50			0.05	4.00	3.86	161.16
1972		116.07	88.45			0.07	3.00	5.15	212.74
1973		127.95	149.65			0.08	23.00	9.73	310.41
1974		143.22	144.10			0.10	61.00	11.56	359.97
1975		147.26	142.56			0.05	15.00	8.88	313.74
1976		132.43	173.17			0.07	18.00	10.77	334.44
1977		129.03	147.38			0.08		8.31	284.80
1978		116.26	81.75			0.10		4.61	202.71
1979		129.41	63.24			0.06		3.57	196.28
1980	167.16		232.49			0.06		13.10	412.80
1981	73.94		61.30		2.34			3.58	141.17
1982	99.82		135.03		16.98			8.56	260.39
1983	109.14		28.51		0.34			1.62	139.61
1984	159.43		73.56		0.00			4.14	237.14
1985	202.43		13.86		0.50			0.81	217.60
1986	197.22		61.21		4.94			3.73	267.10
1987	160.26		28.33		0.09			1.60	190.27
1988	263.54		51.12		1.46			2.96	319.08
1989	129.53		61.31		17.99			4.47	213.30
1990	113.82		51.97		4.13			3.16	173.08
1991	98.11		68.22		0.22			3.85	170.39
1992	82.39		56.31		0.18			3.18	142.07
1993	66.68		66.79		0.56			3.79	137.82
1994	28.75		44.71		0.12			2.53	76.11
1995	38.64		35.70		0.23			2.02	76.58
1996	42.45		60.75		0.21			3.43	106.84
1997	55.33		92.97		0.71			5.28	154.28
1998	39.94		53.63		1.64			3.11	98.32
1999	64.49		57.18		0.84			3.27	125.77
2000	57.85		41.00		0.19			2.32	101.36
2001	110.70		37.77		0.76			2.17	151.41
2002	65.13		25.82		1.90			1.56	94.42
2003	148.10		19.60		0.47			1.13	169.29
2004	32.11		24.00		0.67			1.39	58.17
2005	76.81		21.46		0.88			1.26	100.40
2006	67.31		20.01		0.66			1.16	89.15
2007	52.82		21.70		0.37			1.24	76.14
2008	46.95		23.81		0.45			1.37	72.58
2009	58.83		24.47		0.18			1.39	84.87
2010	68.79		26.55		0.12			1.50	96.97
2011	82.22		28.80		0.04			1.62	112.69
2012	70.30		22.86		0.25			1.30	94.71
2013									***101.45***
2014									***101.45***
2015									***101.45***

Table 5. Removals (mt) of China rockfish (*Sebastes nebulosus*) by year and region.

Year	Southern California	Central California	No. CA / OR / WA	Total	Year	Southern California	Central California	No. CA / OR / WA	Total
1916	0.03	6.50	0.00	6.53	1966	0.81	18.13	0.94	19.88
1917	0.05	10.09	0.00	10.15	1967	1.20	23.15	1.40	25.75
1918	0.05	11.81	0.01	11.86	1968	1.50	19.65	1.52	22.67
1919	0.03	8.22	0.00	8.25	1969	1.49	21.70	2.47	25.65
1920	0.03	8.38	0.00	8.41	1970	2.28	35.06	2.04	39.37
1921	0.03	6.92	0.01	6.95	1971	2.28	24.83	2.96	30.07
1922	0.03	5.95	0.00	5.98	1972	3.17	36.03	3.50	42.70
1923	0.03	6.43	0.00	6.47	1973	3.92	46.36	3.75	54.03
1924	0.05	3.70	0.01	3.75	1974	4.88	44.66	4.46	54.00
1925	0.05	4.62	0.01	4.68	1975	5.02	43.02	3.52	51.56
1926	0.06	7.48	0.01	7.55	1976	4.16	47.95	3.01	55.12
1927	0.05	6.36	0.01	6.42	1977	3.97	43.86	3.23	51.05
1928	0.04	8.11	0.01	8.17	1978	3.90	29.41	4.57	37.88
1929	0.05	7.20	0.08	7.32	1979	5.62	38.87	3.40	47.88
1930	0.05	9.99	0.13	10.16	1980	15.53	42.47	10.73	68.73
1931	0.09	5.05	0.06	5.20	1981	4.89	30.77	16.32	51.97
1932	0.01	11.47	0.03	11.51	1982	6.49	38.88	18.37	63.73
1933	0.02	5.47	0.09	5.58	1983	5.66	17.95	2.83	26.44
1934	0.01	10.06	0.76	10.83	1984	3.61	20.65	6.15	30.41
1935	0.01	9.50	0.63	10.14	1985	4.74	24.41	8.90	38.04
1936	0.01	9.84	1.01	10.86	1986	9.88	32.30	5.49	47.67
1937	0.01	9.58	0.80	10.40	1987	6.92	49.82	12.72	69.47
1938	0.01	7.70	2.56	10.27	1988	4.66	36.60	11.45	52.71
1939	0.01	5.40	4.74	10.15	1989	7.45	29.33	12.55	49.33
1940	0.01	5.54	2.99	8.54	1990	5.71	29.57	15.87	51.15
1941	0.01	5.07	0.99	6.07	1991	5.30	34.04	11.63	50.97
1942	0.00	2.83	0.84	3.67	1992	1.96	45.97	17.41	65.34
1943	0.01	3.83	0.39	4.24	1993	0.13	40.40	13.78	54.31
1944	0.00	2.14	0.43	2.58	1994	0.21	60.53	18.72	79.46
1945	0.00	2.75	0.48	3.23	1995	0.00	45.67	18.79	64.46
1946	0.01	5.29	0.57	5.86	1996	0.02	32.96	16.70	49.68
1947	0.04	4.53	0.25	4.82	1997	0.03	38.62	22.35	60.99
1948	0.05	9.36	0.44	9.85	1998	0.00	18.68	27.47	46.15
1949	0.06	12.33	0.40	12.80	1999	0.48	20.21	35.85	56.54
1950	0.07	11.25	0.25	11.58	2000	0.00	20.08	22.23	42.31
1951	0.32	13.55	0.23	14.10	2001	0.00	18.70	28.09	46.79
1952	0.25	11.89	0.27	12.42	2002	0.00	17.79	28.82	46.61
1953	0.09	10.52	0.11	10.72	2003	0.00	17.58	16.47	34.05
1954	0.20	10.88	0.10	11.18	2004	0.06	9.85	11.98	21.89
1955	0.35	12.33	0.20	12.88	2005	0.19	15.68	9.41	25.28
1956	0.41	13.58	0.13	14.12	2006	0.01	12.80	11.07	23.88
1957	0.24	13.99	0.29	14.52	2007	0.00	13.54	15.36	28.89
1958	0.17	22.62	0.08	22.86	2008	0.00	15.31	16.27	31.58
1959	0.10	18.03	0.10	18.24	2009	0.00	20.27	15.09	35.36
1960	0.10	14.99	0.09	15.19	2010	0.03	18.85	11.82	30.70
1961	0.12	14.60	0.26	14.98	2011	0.00	15.72	16.37	32.10
1962	0.11	12.47	0.30	12.88	2012	0.11	13.50	17.27	30.88
1963	0.12	15.85	0.46	16.43	***2013***				***31.23***
1964	0.16	9.95	0.51	10.62	***2014***				***31.23***
1965	0.41	16.64	0.92	17.97	***2015***				***31.23***

Table 6. Removals (mt) of China rockfish (*Sebastes nebulosus*) by year and data source.

Year	RecFIN	CA Recreational Reconstruction	CALCOM	CA Commercial Reconstruction	PacFIN	OR Commercial Reconstruction	WA Rec.	Commercial Discard	Total
1916				6.13		0.00		0.40	6.53
1917				9.52		0.00		0.62	10.15
1918				11.13		0.00		0.72	11.86
1919				7.74		0.00		0.50	8.25
1920				7.90		0.00		0.51	8.41
1921				6.52		0.00		0.42	6.95
1922				5.61		0.00		0.37	5.98
1923				6.07		0.00		0.39	6.47
1924				3.51		0.00		0.23	3.75
1925				4.39		0.00		0.29	4.68
1926				7.09		0.00		0.46	7.55
1927				6.02		0.00		0.39	6.42
1928		0.42		7.27		0.01		0.47	8.17
1929		0.84		6.02		0.07		0.40	7.32
1930		0.96		8.53		0.11		0.56	10.16
1931		1.28		3.63		0.06		0.24	5.20
1932		1.60		9.30		0.00		0.61	11.51
1933		1.92		3.42		0.01		0.22	5.58
1934		2.24		8.04		0.02		0.52	10.83
1935		2.56		7.10		0.00		0.46	10.14
1936		2.88		7.42		0.07		0.49	10.86
1937		3.42		6.36		0.19		0.43	10.40
1938		3.36		6.27		0.22		0.42	10.27
1939		2.94		6.51		0.26		0.44	10.15
1940		4.23		3.73		0.32		0.26	8.54
1941		3.91		1.81		0.22		0.13	6.07
1942		2.08		1.22		0.27		0.10	3.67
1943		1.99		1.76		0.35		0.14	4.24
1944		1.63		0.49		0.40		0.06	2.58
1945		2.17		0.56		0.44		0.06	3.23
1946		3.74		1.51		0.48		0.13	5.86
1947		2.98		1.57		0.16		0.11	4.82
1948		5.95		3.34		0.32		0.24	9.85
1949		7.70		4.44		0.34		0.31	12.80
1950		9.39		1.93		0.13		0.13	11.58
1951		11.01		2.79		0.11		0.19	14.10
1952		9.60		2.42		0.22		0.17	12.42
1953		8.20		2.29		0.08		0.15	10.72
1954		10.29		0.79		0.05		0.05	11.18
1955		12.38		0.34		0.14		0.03	12.88
1956		13.84		0.20		0.07		0.02	14.12
1957		13.80		0.53		0.15		0.04	14.52
1958		22.58		0.25		0.02		0.02	22.86
1959		17.50		0.64		0.05		0.04	18.24
1960		14.59		0.50		0.06	0.00	0.04	15.19
1961		12.71		1.92		0.11	0.11	0.13	14.98
1962		11.92		0.63		0.06	0.22	0.05	12.88
1963		14.91		1.01		0.11	0.33	0.07	16.43
1964		10.10		0.03		0.05	0.44	0.01	10.62
1965		16.55		0.50		0.31	0.55	0.05	17.97

Table 6 (Continued). Removals (mt) of China rockfish (*Sebastes nebulosus*) by year and data source.

Year	RecFIN	CA Recreational Reconstruction	CALCOM	CA Commercial Reconstruction	PacFIN	OR Commercial Reconstruction	WA Rec.	Commercial Discard	Total
1966		18.63		0.36		0.19	0.66	0.04	19.88
1967		24.20		0.18		0.55	0.77	0.05	25.75
1968		21.16		0.01		0.53	0.94	0.03	22.67
1969		18.05	5.07			1.03	1.11	0.40	25.65
1970		30.37	6.77			0.48	1.28	0.47	39.37
1971		22.31	4.84			1.09	1.45	0.39	30.07
1972		31.42	7.66			1.40	1.61	0.59	42.70
1973		34.73	14.93			1.52	1.78	1.07	54.03
1974		39.38	9.96			1.94	1.95	0.77	54.00
1975		38.04	9.70			1.01	2.12	0.70	51.56
1976		41.12	10.75			1.35	1.12	0.79	55.12
1977		37.22	10.40			1.80	0.84	0.79	51.05
1978		29.43	3.81			1.97	2.30	0.38	37.88
1979		33.49	10.40			1.43	1.79	0.77	47.88
1980	36.57		27.47			1.28	1.54	1.87	68.73
1981	27.30		19.28		2.55		1.41	1.42	51.97
1982	43.92		14.80		0.01		4.05	0.96	63.73
1983	16.91		7.26		0.00		1.80	0.47	26.44
1984	18.07		9.68		0.00		2.03	0.63	30.41
1985	32.79		3.04		0.00		2.01	0.20	38.04
1986	42.58		2.55		0.00		2.36	0.17	47.67
1987	60.04		6.01		0.00		3.03	0.39	69.47
1988	39.62		8.48		0.34		3.69	0.57	52.71
1989	38.20		6.27		0.09		4.36	0.41	49.33
1990	36.68		6.28		2.58		5.02	0.58	51.15
1991	35.16		11.51		0.64		2.87	0.79	50.97
1992	33.64		20.99		4.33		4.72	1.65	65.34
1993	32.13		15.46		1.67		3.93	1.11	54.31
1994	32.27		33.81		7.81		2.86	2.71	79.46
1995	24.47		24.08		10.89		2.75	2.27	64.46
1996	21.82		14.99		9.40		1.88	1.59	49.68
1997	12.11		29.94		14.26		1.81	2.87	60.99
1998	10.92		11.05		20.78		1.33	2.07	46.15
1999	21.43		6.15		25.30		1.62	2.05	56.54
2000	21.94		2.97		14.33		1.94	1.13	42.31
2001	19.11		3.21		20.57		2.36	1.55	46.79
2002	18.62		2.80		21.82		1.77	1.60	46.61
2003	19.97		0.99		10.61		1.73	0.75	34.05
2004	10.36		1.98		7.28		1.67	0.60	21.89
2005	15.96		2.33		4.56		1.98	0.45	25.28
2006	13.92		2.02		5.62		1.83	0.50	23.88
2007	15.79		2.21		8.01		2.23	0.66	28.89
2008	16.67		2.34		9.40		2.40	0.76	31.58
2009	22.03		1.97		8.53		2.14	0.68	35.36
2010	20.40		1.81		5.15		2.89	0.45	30.70
2011	18.72		1.55		8.42		2.76	0.65	32.10
2012	17.50		1.12		9.13		2.46	0.67	30.88
2013									***31.23***
2014									***31.23***
2015									***31.23***

Table 7. Removals (mt) of copper rockfish (*Sebastes caurinus*) by year and region.

Year	Southern California	Central California	No. CA / OR / WA	Total	Year	Southern California	Central California	No. CA / OR / WA	Total
1916	0.12	4.00	0.10	4.23	1966	43.78	120.95	0.91	165.64
1917	0.20	6.25	0.20	6.65	1967	50.70	128.07	1.65	180.42
1918	0.18	7.31	0.45	7.94	1968	59.27	135.68	1.56	196.51
1919	0.11	4.97	0.11	5.19	1969	46.97	144.83	2.84	194.64
1920	0.12	5.10	0.15	5.36	1970	69.55	180.39	2.02	251.96
1921	0.10	4.25	0.22	4.58	1971	66.84	168.05	3.12	238.01
1922	0.10	3.67	0.17	3.94	1972	92.20	214.11	3.61	309.93
1923	0.14	3.97	0.06	4.17	1973	111.48	245.26	3.70	360.45
1924	0.18	2.51	0.15	2.85	1974	138.15	269.37	4.51	412.03
1925	0.20	3.52	0.46	4.18	1975	142.16	267.14	3.01	412.32
1926	0.25	4.61	0.46	5.32	1976	116.95	295.33	3.62	415.90
1927	0.21	2.92	0.86	3.98	1977	109.06	304.92	3.60	417.57
1928	0.20	4.60	0.76	5.56	1978	108.06	280.99	3.40	392.45
1929	0.23	5.58	0.80	6.61	1979	151.84	292.28	3.14	447.26
1930	0.26	8.02	1.25	9.54	1980	363.87	107.98	7.71	479.57
1931	0.26	9.84	1.59	11.69	1981	120.36	371.76	29.45	521.57
1932	0.34	10.80	1.14	12.28	1982	224.68	199.13	16.65	440.46
1933	0.20	11.41	0.89	12.50	1983	117.25	150.61	21.00	288.86
1934	0.31	11.35	0.82	12.47	1984	131.32	122.17	33.53	287.02
1935	0.60	14.11	1.44	16.16	1985	167.22	146.99	11.95	326.16
1936	0.44	14.89	1.47	16.80	1986	141.64	113.15	9.62	264.41
1937	1.22	18.01	1.22	20.45	1987	16.16	89.45	10.29	115.90
1938	0.72	16.76	1.62	19.10	1988	74.72	85.11	10.95	170.78
1939	0.50	14.89	1.64	17.03	1989	71.56	91.01	15.73	178.30
1940	0.54	20.36	0.97	21.86	1990	57.64	89.21	28.92	175.77
1941	0.61	19.20	1.23	21.04	1991	50.92	108.68	17.98	177.58
1942	0.14	8.75	1.31	10.20	1992	32.61	128.58	21.76	182.95
1943	0.20	9.31	1.71	11.22	1993	19.93	134.74	14.76	169.43
1944	0.09	9.50	6.10	15.69	1994	62.78	71.37	11.81	145.96
1945	0.17	14.51	16.34	31.02	1995	50.96	48.50	21.93	121.39
1946	0.21	25.33	14.09	39.62	1996	97.99	73.55	15.44	186.98
1947	0.75	15.58	3.21	19.53	1997	43.87	68.50	20.99	133.36
1948	1.78	26.39	6.26	34.43	1998	55.68	40.22	20.50	116.40
1949	2.33	32.43	2.28	37.04	1999	62.41	33.19	20.17	115.77
1950	3.16	38.33	1.28	42.77	2000	27.38	26.93	12.16	66.46
1951	5.91	52.79	1.60	60.31	2001	20.63	20.94	12.95	54.51
1952	4.50	43.86	1.69	50.05	2002	14.57	14.28	12.15	41.00
1953	4.13	35.35	1.15	40.63	2003	17.04	20.48	7.72	45.23
1954	8.57	44.97	2.22	55.76	2004	16.33	15.71	7.26	39.30
1955	16.72	52.20	0.47	69.40	2005	30.21	31.49	9.67	71.36
1956	18.31	59.85	0.50	78.67	2006	13.48	33.56	9.55	56.59
1957	10.83	57.86	0.79	69.48	2007	30.21	35.44	13.09	78.73
1958	10.88	98.74	0.72	110.35	2008	26.47	27.35	11.47	65.29
1959	5.92	80.12	0.48	86.52	2009	25.08	36.55	9.07	70.70
1960	6.79	68.40	0.31	75.50	2010	23.78	25.09	9.25	58.13
1961	9.69	51.13	0.40	61.23	2011	44.89	23.88	11.63	80.39
1962	6.58	63.59	0.38	70.55	2012	50.20	32.20	12.58	94.99
1963	7.03	79.09	0.75	86.88	***2013***				***77.83***
1964	11.78	70.60	0.58	82.97	***2014***				***77.83***
1965	17.38	104.37	1.42	123.17	***2015***				***77.83***

Table 8. Removals (mt) of copper rockfish (*Sebastes caurinus*) by year and data source.

Year	RecFIN	CA Recreational Reconstruction	CALCOM	CA Commercial Reconstruction	PacFIN	OR Commercial Reconstruction	WA Rec.	Commercial Discard	Total
1916				3.97		0.01		0.26	4.23
1917				6.24		0.01		0.41	6.65
1918				7.45		0.01		0.49	7.94
1919				4.87		0.01		0.32	5.19
1920				5.03		0.01		0.33	5.36
1921				4.29		0.01		0.28	4.58
1922				3.69		0.01		0.24	3.94
1923				3.90		0.01		0.25	4.17
1924				2.66		0.01		0.17	2.85
1925				3.92		0.01		0.26	4.18
1926				4.98		0.01		0.32	5.32
1927				3.73		0.01		0.24	3.98
1928		1.60		3.69		0.02		0.24	5.56
1929		3.21		3.11		0.09		0.21	6.61
1930		3.70		5.34		0.13		0.36	9.54
1931		4.94		6.27		0.07		0.41	11.69
1932		6.17		5.73		0.01		0.37	12.28
1933		7.41		4.76		0.02		0.31	12.50
1934		8.64		3.57		0.03		0.23	12.47
1935		9.87		5.89		0.01		0.38	16.16
1936		11.08		5.28		0.09		0.35	16.80
1937		13.17		6.61		0.23		0.44	20.45
1938		12.96		5.51		0.26		0.38	19.10
1939		11.34		5.05		0.29		0.35	17.03
1940		16.15		5.00		0.37		0.35	21.86
1941		14.92		5.46		0.27		0.37	21.04
1942		7.93		1.79		0.34		0.14	10.20
1943		7.58		2.92		0.50		0.22	11.22
1944		6.23		8.43		0.46		0.58	15.69
1945		8.30		20.83		0.49		1.39	31.02
1946		14.29		23.25		0.54		1.55	39.62
1947		11.89		6.99		0.18		0.47	19.53
1948		24.02		9.40		0.37		0.64	34.43
1949		31.07		5.22		0.38		0.36	37.04
1950		38.13		4.21		0.15		0.28	42.77
1951		47.22		12.16		0.13		0.80	60.31
1952		42.15		7.17		0.25		0.48	50.05
1953		37.03		3.29		0.09		0.22	40.63
1954		49.80		5.53		0.06		0.36	55.76
1955		66.15		2.89		0.16		0.20	69.40
1956		73.31		4.95		0.08		0.33	78.67
1957		63.06		5.86		0.17		0.39	69.48
1958		102.76		7.11		0.02		0.46	110.35
1959		78.21		7.75		0.06		0.51	86.52
1960		64.31		10.44		0.07	0.00	0.68	75.50
1961		50.89		9.51		0.13	0.07	0.63	61.23
1962		63.50		6.42		0.08	0.13	0.42	70.55
1963		78.89		7.18		0.12	0.20	0.48	86.88
1964		77.65		4.70		0.04	0.27	0.31	82.97
1965		116.30		5.79		0.34	0.34	0.40	123.17

Table 8 (Continued). Removals (mt) of copper rockfish (*Sebastes caurinus*) by year and data source.

Year	RecFIN	CA Recreational Reconstruction	CALCOM	CA Commercial Reconstruction	PacFIN	OR Commercial Reconstruction	WA Rec.	Commercial Discard	Total
1966		158.18		6.41		0.22	0.40	0.43	165.64
1967		170.13		8.61		0.62	0.47	0.60	180.42
1968		190.42		4.66		0.58	0.50	0.34	196.51
1969		190.05	2.66			1.15	0.53	0.25	194.64
1970		248.03	2.63			0.53	0.56	0.21	251.96
1971		231.17	4.66			1.20	0.59	0.38	238.01
1972		300.04	7.14			1.56	0.63	0.57	309.93
1973		350.52	7.04			1.68	0.66	0.57	360.45
1974		392.04	16.00			2.12	0.69	1.18	412.03
1975		400.14	9.65			1.11	0.72	0.70	412.32
1976		395.44	17.37			1.49	0.37	1.23	415.90
1977		399.16	15.47			1.80	0.02	1.12	417.57
1978		384.26	5.03			2.18	0.50	0.47	392.45
1979		436.82	7.44			1.57	0.85	0.59	447.26
1980	432.31		42.71			1.40	0.28	2.87	479.57
1981	506.40		13.04		0.00		1.28	0.85	521.57
1982	419.17		16.58		2.13		1.37	1.22	440.46
1983	213.54		57.17		12.96		0.63	4.56	288.86
1984	238.17		30.30		14.33		1.32	2.90	287.02
1985	294.56		28.62		0.05		1.06	1.86	326.16
1986	248.09		14.02		0.00		1.40	0.91	264.41
1987	96.26		16.84		0.09		1.61	1.10	115.90
1988	144.86		22.11		0.51		1.83	1.47	170.78
1989	137.40		31.57		4.91		2.05	2.37	178.30
1990	125.74		27.70		17.14		2.27	2.92	175.77
1991	114.09		50.57		7.63		1.50	3.79	177.58
1992	102.44		62.96		9.95		2.86	4.74	182.95
1993	90.78		67.73		4.12		2.12	4.67	169.43
1994	103.09		34.72		4.28		1.33	2.54	145.96
1995	41.59		57.04		16.03		1.98	4.75	121.39
1996	93.14		77.11		8.75		2.39	5.59	186.98
1997	44.28		69.46		12.06		2.25	5.30	133.36
1998	46.96		50.90		12.13		2.32	4.10	116.40
1999	75.58		25.17		10.48		2.21	2.32	115.77
2000	50.75		8.89		3.54		2.48	0.81	66.46
2001	36.25		8.17		6.61		2.53	0.96	54.51
2002	26.05		6.66		5.82		1.66	0.81	41.00
2003	39.62		1.63		1.84		1.91	0.23	45.23
2004	31.21		3.87		1.83		2.03	0.37	39.30
2005	62.28		3.25		2.51		2.95	0.37	71.36
2006	49.98		2.26		2.12		1.94	0.29	56.59
2007	70.59		2.61		3.15		2.00	0.37	78.73
2008	55.83		3.00		3.68		2.34	0.43	65.29
2009	62.57		3.89		1.79		2.09	0.37	70.70
2010	52.28		2.68		1.07		1.85	0.24	58.13
2011	72.85		3.12		1.61		2.51	0.31	80.39
2012	87.10		3.75		2.15		1.60	0.38	94.99
2013									***77.83***
2014									***77.83***
2015									***77.83***

Table 9. Removals (mt) of sharpchin rockfish (*Sebastes zacentrus*) by year and region.

Year	Southern California	Central California	No. CA / OR / WA	Total	Year	Southern California	Central California	No. CA / OR / WA	Total
1916	0.00	0.02	0.00	0.02	1966	0.00	0.14	891.48	891.62
1917	0.00	0.03	0.00	0.03	1967	0.00	0.13	510.79	510.92
1918	0.00	0.03	0.00	0.03	1968	0.00	0.11	298.87	298.99
1919	0.00	0.02	0.00	0.02	1969	0.00	0.19	32.77	32.97
1920	0.00	0.02	0.00	0.02	1970	0.00	0.28	46.46	46.74
1921	0.00	0.02	0.00	0.02	1971	0.00	0.23	67.23	67.46
1922	0.00	0.02	0.00	0.02	1972	0.00	0.37	44.45	44.82
1923	0.00	0.02	0.00	0.02	1973	0.00	2.40	68.55	70.95
1924	0.00	0.01	0.00	0.01	1974	0.00	2.71	40.22	42.93
1925	0.00	0.01	0.00	0.01	1975	0.00	3.03	43.27	46.30
1926	0.00	0.03	0.00	0.03	1976	0.00	3.18	33.75	36.93
1927	0.00	0.04	0.00	0.04	1977	0.00	1.12	11.47	12.59
1928	0.00	0.06	0.00	0.06	1978	0.00	0.07	179.87	179.94
1929	0.00	0.06	0.02	0.07	1979	0.00	3.59	184.26	187.85
1930	0.00	0.06	0.01	0.07	1980	0.00	0.00	176.32	176.32
1931	0.00	0.02	0.03	0.05	1981	0.00	0.00	27.70	27.70
1932	0.00	0.03	0.02	0.05	1982	0.00	0.00	25.93	25.93
1933	0.00	0.04	0.04	0.08	1983	0.00	1.39	494.09	495.48
1934	0.00	0.05	0.03	0.08	1984	0.00	3.91	171.81	175.72
1935	0.00	0.05	0.03	0.08	1985	0.00	10.91	624.42	635.33
1936	0.00	0.06	0.02	0.07	1986	0.00	1.93	432.46	434.39
1937	0.00	0.05	0.04	0.09	1987	0.00	0.13	418.29	418.42
1938	0.00	0.06	0.05	0.11	1988	0.00	0.00	867.83	867.83
1939	0.00	0.06	0.10	0.16	1989	0.00	8.57	913.37	921.93
1940	0.00	0.08	0.35	0.42	1990	0.00	31.65	672.74	704.40
1941	0.00	0.13	0.56	0.69	1991	0.00	17.46	438.01	455.47
1942	0.00	0.04	1.01	1.04	1992	0.09	19.63	379.91	399.62
1943	0.00	0.06	3.54	3.60	1993	0.05	9.11	743.94	753.10
1944	0.00	0.08	5.69	5.78	1994	0.00	32.86	797.44	830.30
1945	0.00	0.14	10.56	10.69	1995	0.00	11.07	439.66	450.73
1946	0.00	0.32	6.84	7.16	1996	0.00	37.98	388.98	426.96
1947	0.00	0.15	4.23	4.38	1997	0.00	181.91	462.55	644.46
1948	0.00	0.24	4.28	4.51	1998	0.00	17.04	182.59	199.63
1949	0.00	0.13	5.10	5.23	1999	0.00	0.96	92.89	93.85
1950	0.00	0.17	5.80	5.97	2000	0.00	0.70	17.48	18.18
1951	0.00	0.36	5.70	6.06	2001	0.00	0.08	13.45	13.53
1952	0.00	0.38	10.02	10.40	2002	0.00	0.43	9.09	9.52
1953	0.00	0.33	6.75	7.07	2003	0.00	0.00	8.01	8.01
1954	0.00	0.22	10.14	10.37	2004	0.00	0.00	38.18	38.18
1955	0.00	0.15	7.62	7.77	2005	0.00	0.00	5.75	5.75
1956	0.00	0.33	12.83	13.16	2006	0.00	0.00	0.26	0.26
1957	0.00	0.32	11.97	12.30	2007	0.00	0.00	3.84	3.84
1958	0.00	0.31	10.73	11.04	2008	0.00	0.00	1.84	1.84
1959	0.00	0.28	9.58	9.85	2009	0.00	0.00	2.04	2.04
1960	0.00	0.26	12.37	12.63	2010	0.00	0.00	0.57	0.57
1961	0.00	0.14	14.54	14.68	2011	0.00	0.00	0.78	0.78
1962	0.00	0.15	18.62	18.77	2012	0.00	0.00	13.69	13.69
1963	0.00	0.18	23.70	23.88	***2013***				***5.01***
1964	0.00	0.10	21.21	21.31	***2014***				***5.01***
1965	0.00	0.10	19.93	20.03	***2015***				***5.01***

Table 10. Removals (mt) of sharpchin rockfish (*Sebastes zacentrus*) by year and data source.

Year	CA Commercial Reconstruction	CALCOM	OR Commercial Reconstruction	PacFIN	Tagart	Pac. Fisherman and PMFC Data Series	NORPAC	Foreign Fisheries	Commercial Discard	Total
1916	0.01		0.00						0.01	0.02
1917	0.01		0.00						0.01	0.03
1918	0.02		0.00						0.02	0.03
1919	0.01		0.00						0.01	0.02
1920	0.01		0.00						0.01	0.02
1921	0.01		0.00						0.01	0.02
1922	0.01		0.00						0.01	0.02
1923	0.01		0.00						0.01	0.02
1924	0.00		0.00						0.01	0.01
1925	0.00		0.00						0.00	0.01
1926	0.01		0.00						0.01	0.03
1927	0.02		0.00						0.02	0.04
1928	0.03		0.00						0.03	0.06
1929	0.03		0.00						0.04	0.07
1930	0.03		0.00						0.04	0.07
1931	0.02		0.00						0.02	0.05
1932	0.02		0.00						0.03	0.05
1933	0.04		0.00						0.04	0.08
1934	0.04		0.00						0.04	0.08
1935	0.04		0.00						0.04	0.08
1936	0.03		0.00						0.04	0.07
1937	0.04		0.00						0.05	0.09
1938	0.05		0.00						0.06	0.11
1939	0.07		0.01						0.08	0.16
1940	0.08		0.12						0.22	0.42
1941	0.13		0.19						0.36	0.69
1942	0.05		0.36			0.09			0.55	1.04
1943	0.08		1.24			0.38			1.89	3.60
1944	0.13		2.17			0.44			3.04	5.78
1945	0.33		3.36			1.38			5.62	10.69
1946	0.41		2.12			0.86			3.77	7.16
1947	0.20		1.36			0.52			2.31	4.38
1948	0.31		0.95			0.88			2.37	4.51
1949	0.16		1.24			1.08			2.75	5.23
1950	0.14		1.64			1.05			3.14	5.97
1951	0.28		1.74			0.85			3.19	6.06
1952	0.27		3.38			1.29			5.47	10.40
1953	0.24		2.18			0.93			3.72	7.07
1954	0.13		3.03			1.76			5.45	10.37
1955	0.10		2.41			1.18			4.09	7.77
1956	0.18		3.90			2.16			6.92	13.16
1957	0.19		3.89			1.75			6.47	12.30
1958	0.20		3.04			2.00			5.81	11.04
1959	0.18		2.21			2.28			5.18	9.85
1960	0.21		3.02			2.75			6.64	12.63
1961	0.09		3.89			2.98			7.72	14.68
1962	0.08		4.80			4.01			9.87	18.77
1963	0.11		8.63		2.58				12.56	23.88
1964	0.06		7.48		2.57				11.21	21.31
1965	0.08		7.18		2.24				10.53	20.03

Table 10 (Continued). Removals (mt) of sharpchin rockfish (*Sebastes zacentrus*) by year and data source.

Year	CA Commercial Reconstruction	CALCOM	OR Commercial Reconstruction	PacFIN	Tagart	Pac. Fisherman and PMFC Data Series	NORPAC	Foreign Fisheries	Commercial Discard	Total
1966	0.08		14.92		2.70			405.00	468.92	891.62
1967	0.08		9.13					233.00	268.70	510.92
1968	0.08		3.66					138.00	157.24	298.99
1969		0.09	0.14		0.40			15.00	17.34	32.97
1970		0.13	1.83		4.20			16.00	24.58	46.74
1971		0.11	11.57		6.30			14.00	35.48	67.46
1972		0.18	3.17		5.90			12.00	23.57	44.82
1973		0.14	1.90		0.60			31.00	37.32	70.95
1974		0.29	4.17		0.90			15.00	22.58	42.93
1975		0.43	6.51					15.00	24.35	46.30
1976		0.51	7.10		0.90			9.00	19.42	36.93
1977		0.53	3.34		2.10				6.62	12.59
1978		0.03	33.57		51.70				94.63	179.94
1979		1.70	57.95		29.40				98.79	187.85
1980		0.00	53.69		29.90				92.73	176.32
1981		0.00		13.13					14.57	27.70
1982		0.00		12.29					13.64	25.93
1983		0.66		234.24					260.58	495.48
1984		1.85		81.45					92.41	175.72
1985		5.17		296.02					334.13	635.33
1986		0.91		205.02					228.45	434.39
1987		0.06		200.98					217.38	418.42
1988		0.00		422.67					445.16	867.83
1989		4.23		451.02					466.68	921.93
1990		15.85		336.87			0.00		351.68	704.40
1991		8.87		222.40			0.05		224.15	455.47
1992		10.16		185.74			10.00		193.72	399.62
1993		4.79		388.92			0.00		359.38	753.10
1994		17.43		423.07			0.03		389.76	830.30
1995		5.96		236.76			0.04		207.97	450.73
1996		20.77		212.70			0.02		193.47	426.96
1997		101.03		256.89			0.01		286.53	644.46
1998		9.62		102.95			0.07		87.00	199.63
1999		0.55		53.22			0.03		40.05	93.85
2000		0.41		10.16			0.02		7.59	18.18
2001		0.05		5.90			2.06		5.52	13.53
2002		0.26		5.40			0.07		3.78	9.52
2003		0.00		3.79			1.12		3.10	8.01
2004		0.00		23.79			0.01		14.38	38.18
2005		0.00		3.63			0.02		2.10	5.75
2006		0.00		0.14			0.03		0.09	0.26
2007		0.00		1.74			0.79		1.31	3.84
2008		0.00		1.23			0.00		0.61	1.84
2009		0.00		1.37			0.00		0.67	2.04
2010		0.00		0.38			0.00		0.19	0.57
2011		0.00		0.52			0.01		0.26	0.78
2012		0.00		9.17			0.00		4.51	13.69
2013										***5.01***
2014										***5.01***
2015										***5.01***

Table 11. Removals (mt) of stripetail rockfish (*Sebastes saxicola*) by year and region.

Year	Southern California	Central California	No. CA / OR / WA	Total	Year	Southern California	Central California	No. CA / OR / WA	Total
1916	0.00	7.70	0.15	7.85	1966	0.01	18.40	78.25	96.66
1917	0.00	12.17	0.29	12.46	1967	0.02	11.68	62.12	73.83
1918	0.00	12.23	0.58	12.81	1968	0.01	11.59	127.15	138.75
1919	0.00	8.14	0.13	8.27	1969	0.00	10.67	34.17	44.84
1920	0.00	8.51	0.18	8.69	1970	0.00	14.99	39.68	54.67
1921	0.00	7.11	0.27	7.38	1971	0.00	11.45	55.99	67.44
1922	0.00	6.57	0.22	6.79	1972	0.00	19.83	66.92	86.75
1923	0.00	8.16	0.08	8.24	1973	0.00	51.02	229.59	280.62
1924	0.00	8.00	0.38	8.38	1974	0.00	59.49	50.08	109.58
1925	0.00	8.42	1.09	9.51	1975	0.00	61.65	77.14	138.79
1926	0.00	11.95	0.85	12.80	1976	0.00	64.88	47.50	112.38
1927	0.00	9.34	1.43	10.77	1977	0.00	42.91	6.20	49.10
1928	0.00	9.68	0.87	10.56	1978	0.00	17.39	7.71	25.10
1929	0.00	6.14	4.25	10.39	1979	0.00	47.21	17.09	64.30
1930	0.00	8.37	3.39	11.76	1980	0.00	61.54	5.92	67.47
1931	0.00	6.32	7.27	13.59	1981	0.00	35.49	0.37	35.85
1932	0.00	4.80	3.95	8.75	1982	0.00	25.36	17.78	43.14
1933	0.00	3.93	3.35	7.28	1983	0.00	3.60	35.22	38.81
1934	0.00	4.22	3.10	7.32	1984	0.00	6.85	25.43	32.28
1935	0.00	4.00	4.34	8.34	1985	0.00	16.25	40.30	56.55
1936	0.00	4.00	1.67	5.67	1986	0.00	10.95	12.11	23.06
1937	0.00	3.40	2.11	5.51	1987	0.00	16.75	16.11	32.85
1938	0.00	3.10	2.49	5.59	1988	0.00	10.90	15.77	26.68
1939	0.00	2.95	3.85	6.80	1989	0.00	10.73	23.07	33.81
1940	0.00	2.28	3.47	5.75	1990	0.00	7.22	33.48	40.71
1941	0.00	2.33	2.93	5.26	1991	0.00	11.07	59.99	71.05
1942	0.00	0.79	1.27	2.07	1992	0.00	2.40	11.51	13.90
1943	0.00	0.96	2.38	3.34	1993	0.00	19.33	39.49	58.82
1944	0.00	2.37	6.26	8.63	1994	0.00	30.63	109.98	140.61
1945	0.00	3.40	15.81	19.22	1995	0.00	46.78	20.46	67.24
1946	0.00	6.04	12.52	18.56	1996	0.00	6.78	19.31	26.10
1947	0.00	3.40	8.83	12.23	1997	0.00	12.79	25.26	38.04
1948	0.00	3.42	10.33	13.75	1998	0.00	34.01	28.49	62.50
1949	0.00	7.43	15.83	23.26	1999	0.00	6.40	27.05	33.45
1950	0.00	11.28	14.96	26.24	2000	0.01	1.27	7.77	9.05
1951	0.00	20.62	12.46	33.08	2001	0.00	0.54	18.86	19.40
1952	0.00	18.69	8.69	27.38	2002	0.00	0.32	6.50	6.82
1953	0.00	20.90	8.09	28.99	2003	0.00	0.05	2.87	2.91
1954	0.00	17.94	20.77	38.71	2004	0.00	0.14	3.26	3.40
1955	0.00	9.78	20.23	30.02	2005	0.00	0.31	6.02	6.33
1956	0.00	15.61	32.70	48.32	2006	0.00	0.00	7.26	7.26
1957	0.01	13.49	17.85	31.35	2007	0.00	0.00	8.21	8.22
1958	0.01	21.77	8.07	29.85	2008	0.00	0.00	8.63	8.63
1959	0.01	21.36	6.67	28.04	2009	0.00	0.00	3.19	3.19
1960	0.01	13.76	12.22	25.99	2010	0.00	0.00	1.84	1.84
1961	0.01	12.82	9.78	22.61	2011	0.00	0.00	3.83	3.83
1962	0.01	13.11	10.04	23.17	2012	0.00	0.29	4.16	4.45
1963	0.01	13.16	7.87	21.04	***2013***				***3.37***
1964	0.00	10.48	11.15	21.63	***2014***				***3.37***
1965	0.01	10.25	17.79	28.05	***2015***				***3.37***

Table 12. Removals (mt) of stripetail rockfish (*Sebastes saxicola*) by year and data source.

Year	CA Commercial Reconstruction	CALCOM	OR Commercial Reconstruction	PacFIN	Tagart	Foreign Fisheries	Commercial Discard	Total
1916	6.42						1.43	7.85
1917	10.18						2.27	12.46
1918	10.47						2.34	12.81
1919	6.76						1.51	8.27
1920	7.10						1.59	8.69
1921	6.03						1.35	7.38
1922	5.55						1.24	6.79
1923	6.73						1.50	8.24
1924	6.85						1.53	8.38
1925	7.78						1.74	9.51
1926	10.46						2.34	12.80
1927	8.80						1.97	10.77
1928	8.63						1.93	10.56
1929	8.49						1.90	10.39
1930	9.62						2.15	11.76
1931	11.11						2.48	13.59
1932	7.15						1.60	8.75
1933	5.95						1.33	7.28
1934	5.99						1.34	7.32
1935	6.81						1.52	8.34
1936	4.63						1.03	5.67
1937	4.51						1.01	5.51
1938	4.57						1.02	5.59
1939	5.56						1.24	6.80
1940	4.70						1.05	5.75
1941	4.30						0.96	5.26
1942	1.66		0.03				0.38	2.07
1943	2.48		0.25				0.61	3.34
1944	6.63		0.43				1.58	8.63
1945	15.66		0.05				3.51	19.22
1946	14.97		0.21				3.39	18.56
1947	9.38		0.61				2.23	12.23
1948	8.68		2.56				2.51	13.75
1949	16.27		2.74				4.25	23.26
1950	20.01		1.44				4.79	26.24
1951	24.63		2.41				6.04	33.08
1952	18.95		3.43				5.00	27.38
1953	21.85		1.85				5.29	28.99
1954	21.05		10.60				7.07	38.71
1955	14.87		9.67				5.48	30.02
1956	15.94		23.56				8.82	48.32
1957	13.72		11.90				5.72	31.35
1958	21.37		3.03				5.45	29.85
1959	20.10		2.82				5.12	28.04
1960	13.70		7.54				4.74	25.99
1961	12.02		6.47				4.13	22.61
1962	12.17		6.77				4.23	23.17
1963	13.43		3.77				3.84	21.04
1964	10.15		7.53				3.95	21.63
1965	11.94		10.99				5.12	28.05

Table 12 (Continued). Removals (mt) of stripetail rockfish (*Sebastes saxicola*) by year and data source.

Year	CA Commercial Reconstruction	CALCOM	OR Commercial Reconstruction	PacFIN	Tagart	Foreign Fisheries	Commercial Discard	Total
1966	10.41		12.60			56.00	17.65	96.66
1967	13.32		15.02			32.00	13.48	73.83
1968	11.64		2.79			99.00	25.33	138.75
1969		10.28	2.38			24.00	8.19	44.84
1970		13.85	1.84			29.00	9.98	54.67
1971		11.96	21.17			22.00	12.31	67.44
1972		18.28	17.63			35.00	15.84	86.75
1973		22.04	2.35			205.00	51.23	280.62
1974		25.48	4.09			60.00	20.00	109.58
1975		32.82	1.64			79.00	25.34	138.79
1976		36.74	0.12			55.00	20.51	112.38
1977		37.78	0.66		1.70		8.96	49.10
1978		16.15	4.17		0.20		4.58	25.10
1979		45.34	6.92		0.30		11.74	64.30
1980		52.66	2.49				12.32	67.47
1981		29.01		0.30			6.55	35.85
1982		20.73		14.54			7.88	43.14
1983		2.94		28.79			7.09	38.81
1984		5.60		20.79			5.89	32.28
1985		13.28		32.94			10.32	56.55
1986		8.95		9.90			4.21	23.06
1987		13.69		13.17			6.00	32.85
1988		8.91		12.89			4.87	26.68
1989		8.77		18.86			6.17	33.81
1990		5.91		27.37			7.43	40.71
1991		9.05		49.04			12.97	71.05
1992		1.96		9.41			2.54	13.90
1993		15.80		32.28			10.74	58.82
1994		25.04		89.90			25.67	140.61
1995		38.24		16.72			12.27	67.24
1996		5.54		15.79			4.76	26.10
1997		10.45		20.65			6.95	38.04
1998		27.80		23.29			11.41	62.50
1999		5.23		22.11			6.11	33.45
2000		1.04		6.35			1.65	9.05
2001		0.44		15.42			3.54	19.40
2002		0.26		5.31			1.25	6.82
2003		0.04		2.34			0.53	2.91
2004		0.11		2.67			0.62	3.40
2005		0.25		4.92			1.16	6.33
2006		0.00		5.93			1.32	7.26
2007		0.00		6.71			1.50	8.22
2008		0.00		7.06			1.58	8.63
2009		0.00		2.60			0.58	3.19
2010		0.00		1.50			0.34	1.84
2011		0.00		3.13			0.70	3.83
2012		0.23		3.40			0.81	4.45
2013								***3.37***
2014								***3.37***
2015								***3.37***

Table 13. Removals (mt) of yellowtail rockfish (*Sebastes flavidus*) by year and region. Only removals for northern California, Oregon, and Washington ("No. CA / OR / WA") were included in the assessment of the northern stock. Catch prior to 1916 (not shown) averaged < 1mt yr^{-1}.

Year	Southern California	Central California	No. CA / OR / WA	Total	Year	Southern California	Central California	No. CA / OR / WA	Total
1916	2.61	526.48	3.04	532.12	1966	5.71	320.66	4896.57	5222.94
1917	4.21	818.42	5.01	827.64	1967	8.94	317.50	3016.48	3342.93
1918	3.84	957.57	10.29	971.69	1968	10.06	275.44	3321.47	3606.97
1919	2.29	663.84	3.31	669.44	1969	37.32	194.61	3821.11	4053.03
1920	2.49	677.46	4.11	684.07	1970	26.22	226.47	2215.58	2468.27
1921	2.18	560.26	5.59	568.03	1971	33.18	256.99	1674.71	1964.88
1922	2.14	482.10	4.56	488.80	1972	47.10	342.40	2533.20	2922.70
1923	2.87	521.01	2.47	526.35	1973	53.63	564.94	2347.89	2966.46
1924	3.85	304.79	4.33	312.97	1974	60.06	687.61	1702.74	2450.41
1925	4.22	391.33	10.79	406.34	1975	54.73	730.51	1428.23	2213.46
1926	5.24	604.38	10.72	620.34	1976	60.88	519.57	4324.37	4904.82
1927	4.35	489.66	18.98	512.98	1977	68.31	525.74	5087.00	5681.05
1928	3.71	575.73	17.71	597.15	1978	69.40	360.81	8282.49	8712.70
1929	3.76	486.22	26.03	516.00	1979	95.54	430.50	8047.55	8573.59
1930	3.84	709.40	36.92	750.15	1980	111.20	410.83	7889.59	8411.62
1931	1.26	646.46	41.93	689.66	1981	104.00	736.43	9298.11	10138.54
1932	6.54	517.67	27.92	552.13	1982	157.37	1392.66	9799.27	11349.30
1933	1.02	332.42	25.96	359.39	1983	90.01	1508.64	8931.04	10529.69
1934	3.47	372.99	22.91	399.37	1984	138.32	1689.13	5521.20	7348.65
1935	4.00	449.44	34.89	488.33	1985	183.34	895.84	3769.61	4848.79
1936	4.69	555.50	40.03	600.22	1986	152.17	735.04	5397.86	6285.06
1937	2.84	503.56	48.18	554.59	1987	15.96	766.93	5268.11	6051.00
1938	1.61	404.12	55.26	461.00	1988	61.07	391.19	6956.76	7409.02
1939	1.54	287.25	62.70	351.49	1989	98.27	1095.50	6181.38	7375.15
1940	1.87	445.36	140.32	587.55	1990	60.75	1031.22	5237.92	6329.88
1941	2.02	442.14	188.62	632.78	1991	39.27	444.33	5285.16	5768.77
1942	0.93	145.02	341.40	487.35	1992	37.50	645.38	8376.06	9058.94
1943	0.73	176.69	1116.69	1294.11	1993	22.84	275.91	7708.45	8007.20
1944	0.58	205.44	1936.51	2142.53	1994	9.23	278.20	7584.35	7871.78
1945	1.08	336.43	3390.80	3728.31	1995	24.19	217.57	6857.31	7099.07
1946	1.27	456.51	2201.01	2658.79	1996	6.10	232.64	8673.57	8912.31
1947	0.82	361.36	1209.00	1571.18	1997	16.20	734.14	3151.10	3901.44
1948	1.11	367.02	1076.04	1444.17	1998	9.09	433.12	4214.20	4656.41
1949	1.29	342.91	951.84	1296.04	1999	10.08	237.82	4816.41	5064.32
1950	1.79	489.33	961.39	1452.51	2000	0.53	160.75	5011.83	5173.11
1951	2.37	480.88	855.03	1338.28	2001	0.28	57.43	3387.20	3444.91
1952	2.34	378.51	1008.62	1389.46	2002	0.12	26.43	2452.14	2478.69
1953	1.13	196.98	796.00	994.12	2003	0.07	19.47	1490.02	1509.55
1954	2.01	251.50	1147.37	1400.88	2004	0.67	12.74	1750.19	1763.60
1955	2.69	265.29	975.55	1243.53	2005	1.76	23.57	966.08	991.40
1956	3.82	482.76	1475.46	1962.03	2006	1.69	22.49	510.82	535.00
1957	4.41	495.94	1610.52	2110.88	2007	1.87	57.95	405.36	465.18
1958	5.10	807.10	1434.98	2247.17	2008	4.21	17.82	511.05	533.08
1959	11.31	668.10	1588.92	2268.34	2009	0.89	48.24	817.39	866.51
1960	4.42	388.35	1994.72	2387.48	2010	1.01	23.97	1026.61	1051.58
1961	5.33	284.58	1963.13	2253.04	2011	0.62	45.29	1456.02	1501.93
1962	4.26	237.63	2447.96	2689.85	2012	2.42	52.30	1646.36	1701.08
1963	3.90	203.58	1900.84	2108.32	***2013***			***1376.33***	
1964	2.74	138.02	1598.46	1739.22	***2014***			***1376.33***	
1965	5.55	199.76	1573.93	1779.25	***2015***			***1376.33***	

Table 14. Removals (mt) of yellowtail rockfish (*Sebastes flavidus*) north of Cape Mendocino, by year and data source. Catch prior to 1916 (not shown) averaged <1 mt yr^{-1}.

Year	OR Commercial Reconstruction	PacFIN	Tagart	Pac. Fisherman and PMFC Data	Wallace and Lai	Foreign Fisheries	NORPAC	CALCOM	CA Commercial Reconstruction	CA Recreational Reconstruction	RecFIN	WA Recreational	Commercial Discard	Total
1916	1.00								1.90				0.14	3.04
1917	1.05								3.74				0.23	5.01
1918	1.10								8.72				0.47	10.29
1919	1.15								2.00				0.15	3.31
1920	1.20								2.72				0.19	4.11
1921	1.26								4.08				0.25	5.59
1922	1.31								3.04				0.21	4.56
1923	1.36								1.00				0.11	2.47
1924	1.41								2.73				0.20	4.33
1925	1.46								8.84				0.49	10.79
1926	1.51								8.72				0.49	10.72
1927	1.56								16.55				0.86	18.98
1928	2.61								14.28	0.02			0.80	17.71
1929	9.13								15.68	0.03			1.18	26.03
1930	12.48								22.73	0.04			1.67	36.92
1931	7.14								32.84	0.05			1.90	41.93
1932	1.81								24.79	0.07			1.26	27.92
1933	2.88								21.84	0.08			1.17	25.96
1934	3.12								18.67	0.09			1.03	22.91
1935	2.03								31.18	0.11			1.58	34.89
1936	10.08								28.02	0.12			1.81	40.03
1937	23.00								22.87	0.14			2.18	48.18
1938	22.93								29.69	0.14			2.50	55.26
1939	28.53								31.21	0.12			2.84	62.70
1940	119.04								14.75	0.17			6.35	140.32
1941	159.22								20.69	0.16			8.55	188.62
1942	282.71			26.21					16.92	0.09			15.48	341.40
1943	924.12			113.11					28.74	0.08			50.63	1116.69
1944	1572.57			130.03					146.04	0.07			87.81	1936.51
1945	2420.25			407.74					408.98	0.09			153.76	3390.80
1946	1507.08			255.74					338.25	0.15			99.80	2201.01
1947	916.75			152.63					84.67	0.12			54.82	1209.00
1948	627.00			260.00					140.01	0.24			48.78	1076.04
1949	541.10			319.49					47.79	0.32			43.15	951.84
1950	581.15			309.35					26.93	0.38			43.58	961.39
1951	512.86			251.82					51.16	0.44			38.75	855.03
1952	537.31			380.29					44.92	0.38			45.72	1008.62
1953	444.58			276.16					38.86	0.33			36.08	796.00
1954	530.71			519.48					44.77	0.41			52.01	1147.37
1955	568.14			348.64					14.07	0.48			44.22	975.55
1956	755.16			639.14					13.74	0.54			66.88	1475.46
1957	996.71			519.10					21.09	0.62			73.00	1610.52
1958	751.99			590.51					26.89	0.54			65.05	1434.98
1959	824.58			673.38					18.48	0.45			72.03	1588.92
1960	1075.78			814.22					13.99	0.28			90.44	1994.72
1961	977.46			882.25					9.05	0.23		5.37	88.77	1963.13
1962	1131.41			1186.28					8.90	0.11		10.74	110.51	2447.96
1963	960.83		816.53						21.83	0.08		16.12	85.46	1900.84
1964	687.66		792.17						25.55	0.09		21.49	71.51	1598.46
1965	675.10		779.10						22.57	0.16		26.86	70.15	1573.93

Table 14 (Continued). Removals (mt) of yellowtail rockfish (*Sebastes flavidus*) north of Cape Mendocino, by year and data source. Catch prior to 1916 (not shown) averaged <1 mt yr^{-1}.

Year	OR Commercial Reconstruction	PacFIN	Tagart	Pac. Fisherman and PMFC Data	Wallace and Lai	Foreign Fisheries	NORPAC	CALCOM	CA Commercial Reconstruction	CA Recreational Reconstruction	RecFIN	WA Recreational	Commercial Discard	Total
1966	818.87		968.40			2845.00			11.45	0.04		32.23	220.58	4896.57
1967	835.23		34.70		1.40	1956.00			16.31	0.16		37.61	135.07	3016.48
1968	981.83		951.50		0.00	1187.00			17.63	0.09		34.36	149.05	3321.47
1969	1378.58		1372.60		21.70	786.00		58.95		0.31		31.12	171.85	3821.11
1970	521.79		464.80		10.20	1031.00		60.66		0.06		27.87	99.20	2215.58
1971	674.15		365.10		9.70	434.00		92.23		0.08		24.63	74.82	1674.71
1972	1113.73		456.90		11.30	716.00		99.77		0.21		21.39	113.89	2533.20
1973	1071.76		275.90		20.50	770.00		85.82		0.12		18.14	105.64	2347.89
1974	780.20		50.20		16.90	654.00		109.94		0.07		14.90	76.53	1702.74
1975	707.49		330.30		5.60	222.00		86.92		0.03		11.65	64.23	1428.23
1976	1338.84		2363.80		63.70	235.00		111.59		0.04		16.03	195.36	4324.37
1977	1513.10		2955.50		269.50			111.06		0.06		7.45	230.33	5087.00
1978	2221.52		5191.00		184.90			297.22		0.47		12.38	375.00	8282.49
1979	2061.90		5311.80		237.00			67.53		0.53		4.07	364.72	8047.55
1980	3048.51		4235.50		181.30			37.46			27.54	2.89	356.38	7889.59
1981		8722.79			141.60						8.65	4.02	421.06	9298.11
1982		8902.01			434.80						17.24	1.72	443.50	9799.27
1983		8145.19			363.60						15.32	2.77	404.17	8931.04
1984		4866.72			369.80						32.51	3.43	248.73	5521.20
1985		3037.51			358.70						45.80	4.95	322.64	3769.61
1986		4167.96			740.90						13.59	9.06	466.34	5397.86
1987		3956.79			830.70						14.59	11.21	454.81	5268.11
1988		5669.20			663.90						8.64	13.37	601.64	6956.76
1989		4553.33			1050.00						30.22	15.52	532.32	6181.38
1990		4195.53			566.60		2.60				2.86	17.68	452.65	5237.92
1991		3574.14			863.40		354.75				2.26	35.35	455.27	5285.16
1992		5494.09			1463.00		662.35				1.05	31.73	723.85	8376.06
1993		5010.89			1612.50		307.32				77.67	41.66	658.42	7708.45
1994		5174.43			1142.80		566.33				28.87	17.98	653.94	7584.35
1995		4664.64			781.00		779.28				25.72	15.31	591.37	6857.31
1996		5159.88			2013.40		710.07				20.63	20.68	748.92	8673.57
1997		1825.46			583.70		418.53				33.38	21.40	268.63	3151.10
1998		2467.05			763.90		555.66				36.13	31.73	359.73	4214.20
1999		2226.47			977.00		1161.80				24.88	11.56	414.70	4816.41
2000		2830.07			1082.10		636.28				18.12	13.16	432.10	5011.83
2001		1883.47			976.40		209.82				17.22	8.68	291.62	3387.20
2002		1017.57			1007.70		193.60				19.27	3.20	210.79	2452.14
2003		413.54			887.90		35.30				15.80	10.49	126.99	1490.02
2004		567.58			958.50		43.31				11.69	20.02	149.09	1750.19
2005		746.50					108.38				12.54	17.45	81.21	966.08
2006		338.83					108.95				8.79	11.71	42.54	510.82
2007		274.34					77.21				6.96	13.45	33.40	405.36
2008		272.77					173.56				5.48	16.85	42.40	511.05
2009		536.08					177.54				10.26	25.71	67.79	817.39
2010		748.57					149.75				7.92	35.02	85.34	1026.61
2011		1181.03					101.11				12.40	39.67	121.80	1456.02
2012		1433.21					41.32				14.68	17.07	140.08	1646.36
2013														***1376.33***
2014														***1376.33***
2015														***1376.33***

Table 15. Removals (mt) of English sole (*Parophrys vetulus*) by year and region.

Year	Southern & Central California	No. CA / OR / WA	Discard (Coastwide)	Total	Year	Southern & Central California	No. CA / OR / WA	Discard (Coastwide)	Total
1876	1.0	0.0	0	1.0	1946	717.1	3544.0	737	4998.1
1877	1.2	0.0	0	1.2	1947	776.1	2055.9	502	3334.0
1878	1.4	0.0	0	1.4	1948	1208.5	4008.5	814	6030.9
1879	1.7	0.0	0	1.7	1949	1092.5	1977.5	476	3546.0
1880	2.1	0.0	0	2.1	1950	1606.8	3311.3	755	5673.1
1881	2.5	0.0	0	2.5	1951	947.1	2558.2	684	4189.4
1882	3.0	0.0	0	3.0	1952	736.1	2324.9	763	3824.0
1883	3.6	0.0	1	4.6	1953	680.8	1589.8	640	2910.6
1884	4.3	0.0	1	5.3	1954	750.4	1321.1	552	2623.5
1885	5.2	0.0	1	6.2	1955	837.2	1438.8	553	2829.0
1886	6.2	0.0	1	7.2	1956	1285.0	1783.0	719	3787.0
1887	7.4	0.0	1	8.4	1957	1390.0	2190.0	856	4436.0
1888	8.9	0.0	1	9.9	1958	1132.0	3225.0	1163	5520.0
1889	10.7	0.0	2	12.7	1959	808.0	3350.0	1269	5427.0
1890	12.8	0.0	2	14.8	1960	594.0	2829.0	915	4338.0
1891	15.4	0.0	2	17.4	1961	1082.0	2301.0	805	4188.0
1892	18.5	0.0	3	21.5	1962	1436.0	2185.0	875	4496.0
1893	22.2	0.0	3	25.2	1963	1367.0	2230.0	892	4489.0
1894	26.6	0.0	4	30.6	1964	1453.0	2085.0	1204	4742.0
1895	31.9	0.0	5	36.9	1965	1696.0	2187.0	1160	5043.0
1896	38.3	0.0	5	43.3	1966	1470.0	3068.0	984	5522.0
1897	46.0	0.0	7	53.0	1967	1540.0	2786.0	866	5192.0
1898	55.2	0.0	8	63.2	1968	1339.0	3200.0	929	5468.0
1899	66.2	0.0	9	75.2	1969	1012.0	2049.0	727	3788.0
1900	79.5	0.0	11	90.5	1970	902.0	1593.0	607	3102.0
1901	95.4	0.0	14	109.4	1971	909.0	1383.0	559	2851.0
1902	114.5	0.0	16	130.5	1972	793.0	1850.0	657	3300.0
1903	137.4	0.0	20	157.4	1973	836.0	2134.0	803	3773.0
1904	164.8	0.0	24	188.8	1974	1012.0	1934.0	912	3858.0
1905	197.8	0.0	28	225.8	1975	1227.0	2267.0	1085	4579.0
1906	237.4	0.0	34	271.4	1976	1143.0	3323.0	1289	5755.0
1907	284.9	0.0	41	325.9	1977	927.0	1940.0	868	3735.0
1908	341.8	0.0	49	390.8	1978	1070.0	2393.0	1048	4511.0
1909	410.2	0.0	59	469.2	1979	1115.0	2516.0	1079	4710.0
1910	492.2	0.0	72	564.2	1980	1362.0	1851.0	930	4143.0
1911	590.7	0.0	86	676.7	1981	1135.0	1578.8	1155	3868.8
1912	708.8	0.0	104	812.8	1982	1006.1	1786.5	1171	3963.6
1913	850.6	0.0	126	976.6	1983	640.8	1714.6	973	3328.4
1914	1020.7	0.0	152	1172.7	1984	529.6	1191.7	832	2553.3
1915	1224.8	0.0	184	1408.8	1985	693.9	1236.0	1064	2993.9
1916	2454.1	0.0	372	2826.1	1986	755.5	1279.8	1138	3173.3
1917	3343.1	0.0	522	3865.1	1987	746.9	1721.1	1536	4004.0
1918	2691.7	0.0	440	3131.7	1988	704.4	1396.2	1367	3467.6
1919	2117.6	0.0	357	2474.6	1989	768.3	1643.9	1390	3802.2
1920	1463.8	0.0	251	1714.8	1990	712.5	1198.9	1015	2926.4
1921	1865.6	0.0	318	2183.6	1991	691.7	1492.4	1170	3354.1
1922	2697.7	0.0	461	3158.7	1992	487.2	1134.7	952	2573.9
1923	2714.1	0.0	472	3186.1	1993	395.1	1205.4	980	2580.4
1924	3491.0	0.0	619	4110.0	1994	370.8	751.2	718	1840.0
1925	3393.3	0.0	625	4018.3	1995	414.6	711.9	646	1772.4
1926	3246.5	0.0	618	3864.5	1996	436.9	717.6	421	1575.5
1927	3923.2	0.0	767	4690.2	1997	468.6	1037.9	505	2011.5
1928	3442.0	0.0	701	4143.0	1998	228.6	909.7	420	1558.3
1929	3975.7	2.6	832	4810.3	1999	227.3	684.8	392	1304.1
1930	3065.2	0.8	666	3732.0	2000	181.5	579.1	327	1087.7
1931	1579.8	0.9	347	1927.7	2001	199.1	790.8	421	1410.9
1932	2919.2	5.8	615	3540.1	2002	101.7	1066.0	529	1696.6
1933	2762.1	4.0	580	3346.0	2003	116.8	677.4	338	1132.1
1934	2350.1	2.4	493	2845.5	2004	98.9	852.7	302	1253.6
1935	2666.8	5.2	554	3226.0	2005	69.4	854.9	227	1151.4
1936	2801.0	18.3	585	3404.3	2006	58.0	849.2	192	1099.2
1937	2547.4	69.3	543	3159.7	2007	63.2	613.6	112.6	789.4
1938	1076.2	1070.3	397	2543.6	2008	70.5	289.7	59.9	420.1
1939	1350.6	1176.2	464	2990.8	2009	39.3	317.0	59.3	415.5
1940	1168.9	1404.8	464	3037.8	2010	21.6	199.7	36.8	258.1
1941	807.9	1053.6	340	2201.5	2011	17.8	152.1	28.3	198.1
1942	162.9	1600.1	301	2064.0	2012	18.4	166.8	30.8	216.1
1943	381.6	2697.1	559	3637.7	***2013***				***224.1***
1944	429.1	1350.4	362	2141.5	***2014***				***224.1***
1945	411.6	1170.4	305	1887.0	***2015***				***224.1***

Table 16. Removals (mt) of English sole (*Parophrys vetulus*) by year and data source.

Year	Stewart	CALCOM	PacFIN	Discard	Total
1876	1			0	1
1877	1			0	1
1878	1			0	1
1879	2			0	2
1880	2			0	2
1881	2			0	2
1882	3			0	3
1883	4			1	5
1884	4			1	5
1885	5			1	6
1886	6			1	7
1887	7			1	8
1888	9			1	10
1889	11			2	13
1890	13			2	15
1891	15			2	17
1892	18			3	21
1893	22			3	25
1894	27			4	31
1895	32			5	37
1896	38			5	43
1897	46			7	53
1898	55			8	63
1899	66			9	75
1900	79			11	90
1901	95			14	109
1902	114			16	130
1903	137			20	157
1904	165			24	189
1905	198			28	226
1906	237			34	271
1907	285			41	326
1908	342			49	391
1909	410			59	469
1910	492			72	564
1911	591			86	677
1912	709			104	813
1913	851			126	977
1914	1021			152	1173
1915	1225			184	1409
1916	2454			372	2826
1917	3343			522	3865
1918	2692			440	3132
1919	2118			357	2475
1920	1464			251	1715
1921	1866			318	2184
1922	2698			461	3159
1923	2714			472	3186
1924	3491			619	4110
1925	3393			625	4018
1926	3247			618	3865
1927	3923			767	4690
1928	3442			701	4143
1929	3979			832	4811
1930	3066			666	3732
1931	1581			347	1928
1932	2925			615	3540
1933	2766			580	3346
1934	2352			493	2845
1935	2672			554	3226
1936	2819			585	3404
1937	2616			543	3159
1938	2146			397	2543
1939	2527			464	2991
1940	2574			464	3038
1941	1862			340	2202
1942	1763			301	2064
1943	3079			559	3638
1944	1779			362	2141
1945	1582			305	1887

Table 16 (Continued). Removals (mt) of English sole (*Parophrys vetulus*) by year and data source.

Year	Stewart	CALCOM	PacFIN	Discard	Total
1946	4261			737	4998
1947	2832			502	3334
1948	5216			814	6030
1949	3070			476	3546
1950	4918			755	5673
1951	3505			684	4189
1952	3061			763	3824
1953	2271			640	2911
1954	2071			552	2623
1955	2276			553	2829
1956	3068			719	3787
1957	3580			856	4436
1958	4357			1163	5520
1959	4158			1269	5427
1960	3423			915	4338
1961	3383			805	4188
1962	3621			875	4496
1963	3597			892	4489
1964	3538			1204	4742
1965	3883			1160	5043
1966	4538			984	5522
1967	4326			866	5192
1968	4539			929	5468
1969	3061			727	3788
1970	2495			607	3102
1971	2292			559	2851
1972	2643			657	3300
1973	2970			803	3773
1974	2946			912	3858
1975	3494			1085	4579
1976	4466			1289	5755
1977	2867			868	3735
1978	3463			1048	4511
1979	3631			1079	4710
1980	3213			930	4143
1981	2625			1155	3780
1982	2662			1171	3833
1983	2118			973	3091
1984	1626			832	2458
1985	1891			1064	2955
1986	2015			1138	3153
1987	2443			1536	3979
1988	2055			1367	3422
1989	2390			1390	3780
1990	1892			1015	2907
1991	2169			1170	3339
1992	1604			952	2556
1993	1554			980	2534
1994	1100			718	1818
1995	1116			646	1762
1996	1119			421	1540
1997	1406			505	1911
1998	1021			420	1441
1999	853			392	1245
2000	734			327	1061
2001	942			421	1363
2002	1154			529	1683
2003	787			338	1125
2004	916			302	1218
2005	888			227	1115
2006	886			192	1078
2007		63.2	613.6	112.6	789.4
2008		70.5	289.7	59.9	420.1
2009		39.3	317.0	59.3	415.5
2010		21.6	199.7	36.8	258.1
2011		17.8	152.1	28.3	198.1
2012		18.4	166.8	30.8	216.1
2013					***224.1***
2014					***224.1***
2015					***224.1***

Table 17. Removals (mt) of rex sole (*Glyptocephalus zachirus*) by year and region.

Year	Southern California	Central California	No. CA / OR / WA	Total	Year	Southern California	Central California	No. CA / OR / WA	Total
1916	0.00	131.45	90.86	222.31	1966	21.08	588.54	1637.70	2247.33
1917	0.00	179.08	123.77	302.85	1967	22.41	703.79	1513.90	2240.10
1918	0.00	144.19	99.66	243.84	1968	23.33	645.20	1422.42	2090.95
1919	0.00	113.43	78.40	191.83	1969	29.34	320.55	2072.48	2422.36
1920	0.00	78.41	54.19	132.60	1970	16.69	373.42	1562.92	1953.04
1921	0.00	99.93	69.07	169.00	1971	18.65	345.80	1218.26	1582.71
1922	0.00	144.51	99.88	244.38	1972	29.06	308.54	1636.56	1974.16
1923	0.00	145.38	100.48	245.86	1973	20.25	266.84	1641.36	1928.45
1924	0.00	181.27	125.29	306.56	1974	22.40	277.29	1622.48	1922.17
1925	0.00	179.78	124.26	304.03	1975	10.50	428.07	1450.87	1889.44
1926	0.00	177.47	122.66	300.12	1976	12.92	624.60	1488.09	2125.62
1927	0.00	215.01	148.61	363.62	1977	8.98	403.16	1352.12	1764.26
1928	0.00	210.95	145.80	356.74	1978	4.05	424.78	1661.76	2090.59
1929	0.00	240.18	166.01	406.19	1979	3.95	452.43	2216.61	2672.99
1930	0.00	224.13	154.91	379.03	1980	0.23	513.05	1561.37	2074.65
1931	0.00	283.97	281.60	565.57	1981	1.54	398.30	1633.42	2033.25
1932	0.00	226.61	152.10	378.71	1982	1.54	454.64	1830.82	2287.01
1933	0.11	260.30	100.15	360.56	1983	5.63	459.79	1432.62	1898.05
1934	0.09	348.32	107.13	455.53	1984	2.62	348.62	1302.66	1653.90
1935	0.39	378.08	51.64	430.11	1985	0.85	652.62	1184.64	1838.11
1936	0.00	276.59	75.64	352.23	1986	1.59	624.91	915.48	1541.98
1937	0.00	172.33	141.90	314.23	1987	3.82	607.61	914.82	1526.25
1938	0.00	231.46	149.36	380.82	1988	2.82	681.69	917.16	1601.68
1939	0.00	290.59	185.44	476.03	1989	4.58	676.53	759.91	1441.02
1940	0.00	248.57	194.45	443.02	1990	0.15	489.60	620.98	1110.73
1941	0.01	155.78	143.62	299.41	1991	0.00	582.36	864.99	1447.34
1942	0.00	77.57	197.46	275.03	1992	0.18	400.32	678.30	1078.80
1943	0.00	124.05	591.14	715.18	1993	0.05	392.92	566.49	959.46
1944	0.00	96.86	284.72	381.58	1994	0.22	524.65	494.32	1019.19
1945	0.67	142.75	205.74	349.17	1995	2.29	601.75	507.77	1111.80
1946	0.00	176.25	256.13	432.39	1996	0.60	434.16	579.91	1014.67
1947	0.10	253.17	366.40	619.67	1997	0.57	356.21	605.99	962.78
1948	9.64	283.65	558.88	852.17	1998	0.83	196.45	549.39	746.67
1949	17.34	410.01	540.14	967.48	1999	0.20	178.81	508.06	687.06
1950	0.53	483.65	438.70	922.87	2000	0.10	148.60	478.03	626.73
1951	0.85	521.94	450.55	973.34	2001	0.42	114.25	546.84	661.50
1952	2.54	573.45	555.26	1131.25	2002	0.64	132.72	554.42	687.79
1953	1.29	431.09	996.85	1429.24	2003	0.07	162.97	512.09	675.13
1954	5.48	552.48	950.04	1507.99	2004	0.14	150.53	460.84	611.50
1955	0.47	483.67	1495.40	1979.55	2005	0.02	133.26	528.30	661.58
1956	2.75	548.00	1809.25	2360.00	2006	0.03	77.04	545.22	622.29
1957	6.25	523.54	1607.61	2137.40	2007	0.03	56.37	566.65	623.05
1958	8.91	615.08	1562.20	2186.19	2008	0.06	49.51	545.03	594.60
1959	9.22	578.99	1444.78	2032.99	2009	0.02	39.14	570.17	609.32
1960	9.70	472.55	1444.77	1927.01	2010	0.17	21.26	493.33	514.77
1961	34.43	480.55	1486.90	2001.88	2011	0.97	18.49	407.45	426.91
1962	47.78	577.44	1658.37	2283.60	2012	0.33	12.68	409.44	422.45
1963	52.45	659.58	1778.72	2490.74	***2013***				***454.71***
1964	14.92	588.77	1262.33	1866.01	***2014***				***454.71***
1965	30.22	623.29	1147.70	1801.20	***2015***				***454.71***

Table 18. Removals (mt) of rex sole (*Glyptocephalus zachirus*) by year and data source.

Year	OR Commercial Reconstruction	PacFIN	CALCOM	CA Commercial Reconstruction	CDFG Fish Bulletin No. 74	PMFC Data Series	NORPAC	Commercial Discard	Total
1916					148.2			74.1	222.3
1917					201.9			100.9	302.8
1918					162.6			81.3	243.8
1919					127.9			63.9	191.8
1920					88.4			44.2	132.6
1921					112.7			56.3	169.0
1922					162.9			81.5	244.4
1923					163.9			82.0	245.9
1924					204.4			102.2	306.6
1925					202.7			101.3	304.0
1926					200.1			100.0	300.1
1927					242.4			121.2	363.6
1928					237.8			118.9	356.7
1929					270.8			135.4	406.2
1930					252.7			126.3	379.0
1931				377.0				188.5	565.6
1932	0.5			252.0				126.2	378.7
1933	0.2			240.2				120.2	360.6
1934	0.1			303.6				151.8	455.5
1935	0.2			286.5				143.4	430.1
1936	0.9			233.9				117.4	352.2
1937	4.7			204.8				104.7	314.2
1938	0.1			253.8				126.9	380.8
1939	14.6			302.8				158.7	476.0
1940	26.2			269.1				147.7	443.0
1941	31.3			168.3				99.8	299.4
1942	7.6			175.8				91.7	275.0
1943	252.0			224.8				238.4	715.2
1944	66.9			187.5				127.2	381.6
1945	32.2			200.6				116.4	349.2
1946	29.5			258.7				144.1	432.4
1947	30.7			382.4				206.6	619.7
1948	164.9			403.2				284.1	852.2
1949	206.8			438.2				322.5	967.5
1950	151.1			464.1				307.6	922.9
1951	197.5			454.0				321.8	973.3
1952	228.8			531.5				370.9	1131.2
1953	508.0			456.7				464.6	1429.2
1954	507.2			514.8				486.0	1508.0
1955	862.2			485.0				632.4	1979.6
1956	804.3			514.9		293.6		747.2	2360.0
1957	730.4			556.9		179.5		670.6	2137.4
1958	874.5			626.7		5.5		679.6	2186.2
1959	666.5			632.7		107.8		626.0	2033.0
1960	720.1			489.3		130.0		587.7	1927.0
1961	745.4			526.8		125.1		604.6	2001.9
1962	918.5			626.4		55.9		682.8	2283.6
1963	1028.3			696.6		28.6		737.2	2490.7
1964	687.0			632.4		0.0		546.6	1866.0
1965	514.7			671.3		93.2		522.1	1801.2

Table 18 (Continued). Removals (mt) of rex sole (*Glyptocephalus zachirus*) by year and data source.

Year	OR Commercial Reconstruction	PacFIN	CALCOM	CA Commercial Reconstruction	CDFG Fish Bulletin No. 74	PMFC Data Series	NORPAC	Commercial Discard	Total
1966	873.1			729.7		0.0		644.5	2247.3
1967	810.7			794.0		0.0		635.4	2240.1
1968	642.7			861.7		0.0		586.5	2090.9
1969	726.0		1024.6			0.0		671.8	2422.4
1970	621.7		789.9			6.1		535.3	1953.0
1971	510.1		643.9			0.0		428.7	1582.7
1972	649.6		753.7			42.6		528.3	1974.2
1973	615.1		718.8			84.8		509.7	1928.5
1974	621.6		626.7			172.2		501.6	1922.2
1975	494.5		746.8			161.4		486.7	1889.4
1976	512.3		913.0			160.0		540.4	2125.6
1977	452.2		702.2			167.4		442.5	1764.3
1978	653.8		697.6			222.1		517.1	2090.6
1979	746.5		868.5			406.1		651.9	2673.0
1980	541.4		861.6			173.0		498.7	2074.7
1981		1246.6	305.2					481.5	2033.3
1982		1403.8	349.8					533.4	2287.0
1983		1103.7	358.6					435.8	1898.0
1984		1008.3	271.9					373.7	1653.9
1985		921.3	508.2					408.6	1838.1
1986		715.4	489.6					337.0	1542.0
1987		719.8	481.1					325.4	1526.2
1988		726.7	542.3					332.7	1601.7
1989		606.3	543.4					291.3	1441.0
1990		486.9	393.5				12.0	218.3	1110.7
1991		699.9	471.2				0.0	276.3	1447.3
1992		551.3	326.4				1.4	199.7	1078.8
1993		464.9	322.5				0.0	172.0	959.5
1994		408.4	433.9				0.3	176.6	1019.2
1995		422.5	503.0				0.4	186.0	1111.8
1996		486.4	364.7				0.0	163.5	1014.7
1997		512.1	301.5				0.0	149.2	962.8
1998		467.5	168.0				0.2	111.0	746.7
1999		435.8	153.5				0.0	97.7	687.1
2000		409.3	128.5				3.8	85.1	626.7
2001		461.8	99.9				14.4	85.5	661.5
2002		477.8	117.0				8.7	84.2	687.8
2003		452.0	144.2				0.8	78.1	675.1
2004		410.4	134.3				0.3	66.5	611.5
2005		472.4	119.7				2.2	67.3	661.6
2006		493.3	69.8				0.3	58.9	622.3
2007		516.9	51.5				0.2	54.5	623.0
2008		501.1	45.6				0.3	47.6	594.6
2009		524.1	36.0				0.4	48.8	609.3
2010		443.4	19.7				10.4	41.2	514.8
2011		371.1	17.9				3.8	34.2	426.9
2012		373.9	12.0				2.8	33.8	422.4
2013									***454.71***
2014									***454.71***
2015									***454.71***

7.1.3 Surveys

Table 19. Sources of abundance information by species, region and time. Information for vermilion and yellowtail rockfish are included for future assessment efforts.

Species			Brown Rockfish	China Rockfish	Copper Rockfish	Copper Rockfish	Copper Rockfish	English Sole	Rex Sole	Sharpchin Rockfish	Stripetail Rockfish	Vermilion Rockfish	Vermilion Rockfish	Yellowtail Rockfish	Yellowtail Rockfish
Species Abbreviation			BRWN	CHNA	COPP	COPP	COPP	EGLS	REX	SHRP	STRK	VERM	VERM	YTRK	YTRK
Area				CEN-NO	SOUTH	CEN-NO	ALL	CEN-NO	CEN-NO	CEN-NO	CEN-NO	SOUTH	CEN	CEN	NORTH
Source	Model	Survey													
Trawl Surveys	GLMM	Triennial early						80-92	80-92	80-92	80-92				80-92
		Triennial late						95-04	95-04	95-04	95-04				95-04
		NWFSC						03-12	03-12	03-12	03-12				03-12
	GLM-stratified	Triennial						77-04	77-04	77-04	77-04			77-04	77-04
		NWFSC												03-12	
Hook and Line Survey		H&L										04-12			
Recreational CPUE															
		RecFIN	80-03	80-03	80-03	80-03	80-03					80-03	80-03	80-03	80-03
		CenCalOBS	88-??	88-??		88-??							88-??	88-??	
		SoCalOBS	99-11		99-11							99-11			
		NoCalOROBS	01-12	01-12		01-12							01-12	01-12	01-12

Table 20. Number of tows in the Triennial Survey by year and latitude. Columns: southern boundaries of 2-degree bins.

				CA/OR		OR/WA		
Pt. Conception			Cape Mendocino				Canada	
Latitude:	L34	L36	L38	L40	L42	L44	L46	Total
1977	109	51	100	20	47	118	126	571
1980		23	26	19	71	61	101	301
1983		30	36	30	108	99	176	479
1986		29	41	25	46	79	263	483
1989	30	69	47	33	41	107	113	440
1992	18	55	44	36	48	113	107	421
1995	43	49	60	43	56	102	84	437
1998	46	54	62	50	64	103	89	468
2001	47	53	62	47	66	103	86	464
2004	22	42	44	44	57	83	76	368
Total	315	455	522	347	604	968	1221	4432

Table 21. Number of tows in the Triennial Survey by year and depth. Columns: shallow boundaries.

Depth(m):	D50	D95	D125	D150	D200	D250	D300	D350	D400	D450	Total
1977		101	59	74	89	48	80	44	68	8	571
1980	83	54	45	62	29	15	12	1			301
1983	121	107	68	72	59	29	18	5			479
1986	114	144	89	91	22	10	12	1			483
1989	120	104	72	79	29	18	15	3			440
1992	114	114	69	60	34	13	16	1			421
1995	87	80	54	50	47	17	19	36	28	19	437
1998	96	92	57	50	46	18	22	28	35	24	468
2001	91	95	54	46	47	17	24	27	40	23	464
2004	78	61	47	45	35	22	16	12	38	14	368
Total	904	952	614	629	437	207	234	158	209	88	4432

Table 22. Temporal distribution of Triennial Surveys. The three time period groups are used in the stratified GLM analyses. Columns: first day of 10-day Julian date bins.

TIMEP:	EARLY			COMMON					LATE				
Date:	150	160	170	180	190	200	210	220	230	240	250	260	Total
1977				26	83	44	124	34	36	96	73	55	571
1980					50	19	56	47	55	45	29		301
1983				2	54	86	64	71	98	45	22	37	479
1986					32	55	67	98	98	52	62	19	483
1989					22	70	73	88	92	95			440
1992					15	36	37	40	53	145	74	21	421
1995	10	42	63	80	68	106	37	31					437
1998	28	99	91	90	94	49	17						468
2001	26	90	49	41	58	97	75	28					464
2004	78	57	71	74	49	39							368
Total	142	288	274	313	525	601	550	437	432	478	260	132	4432

Table 23. The total frequency of occurrence by survey and year of each species considered in the category 2 stock assessments.

A) AFSC triennial shelf

Group	Species	1977	1980	1983	1986	1989	1992	1995	1998	2001	2004
Rockfishes	Brown	0%	1%	1%	2%	2%	1%	1%	0%	0%	1%
	China	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Copper	0%	0%	1%	0%	3%	1%	1%	1%	1%	0%
	Sharpchin	13%	15%	19%	20%	19%	16%	11%	11%	10%	14%
	Stripetail	29%	21%	20%	19%	33%	19%	36%	26%	24%	31%
	Yellowtail	17%	26%	36%	32%	13%	15%	13%	21%	10%	14%
Flatfishes	English sole	28%	55%	65%	75%	67%	63%	58%	69%	62%	67%
	Rex sole	89%	90%	93%	102%	98%	83%	95%	96%	97%	97%

B) AFSC triennial slope

Group	Species	1997	1999	2000	2001
Rockfishes	Brown	0%	0%	0%	0%
	China	0%	0%	0%	0%
	Copper	0%	0%	0%	0%
	Sharpchin	12%	11%	8%	9%
	Stripetail	11%	10%	9%	10%
	Yellowtail	1%	2%	0%	0%
Flatfishes	English sole	12%	14%	11%	9%
	Rex sole	42%	40%	40%	38%

C) NWFSC annual shelf-slope

Group	Species	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Rockfishes	Brown	1%	1%	1%	1%	0%	0%	0%	0%	1%	1%
	China	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Copper	1%	1%	1%	0%	1%	2%	1%	1%	1%	3%
	Sharpchin	21%	25%	22%	21%	20%	18%	22%	23%	23%	21%
	Stripetail	10%	7%	5%	7%	5%	4%	6%	6%	7%	6%
	Yellowtail	6%	6%	7%	6%	7%	5%	6%	7%	7%	7%
Flatfishes	English sole	41%	46%	45%	36%	35%	35%	36%	40%	43%	43%
	Rex sole	65%	66%	67%	62%	62%	59%	58%	62%	62%	62%

Table 24. Deviance values for each of the two error structures explored for each stock and survey. Bold values are models with lowest deviance.

		Model	
Survey	Species	Gamma	Lognormal
Triennial- early	Sharpchin rockfish	5124	**4277**
	Stripetail rockfish	4998	**4715**
	Yellowtail rockfish (N)	6765	**5642**
	English sole	12176	**11366**
	Rex sole	14725	**13757**
Triennial- late	Sharpchin rockfish	2288	**2144**
	Stripetail rockfish	5063	**4861**
	Yellowtail rockfish (N)	3119	**3002**
	English sole	**9626**	9678
	Rex sole	**14206**	14449
Triennial combined	Yellowtail rockfish (N)	NA	9683
NWFSC combo	Sharpchin rockfish	9585	**9248**
	Stripetail rockfish	4126	**4004**
	Yellowtail rockfish (N)	4825	**4701**
	English sole	20857	**20807**
	Rex sole	**29396**	29776

Table 25. Final design and model (GLMM)-based survey abundance indices for each survey and stock. Yellowtail rockfish (N) treat the triennial survey as one time series.

		Species														
		Sharpchin rockfish			Stripetail rockfish			Yellowtail rockfish (N)			English sole			Rex sole		
Survey	Year	Design	$GLMM_{med}$	CV	Design	$GLMM_{med}$	CV	Design	$GLMM_{med}$	CV	Design	$GLMM_{med}$	CV	Design	$GLMM_{med}$	CV
Triennial- Early	1980	4700	15612	0.49	24852	33906	0.45	10590	8962	0.33	4203	4621	0.18	6580	6375	0.18
	1983	16192	15974	0.39	7889	9707	0.36	18309	13131	0.19	8369	9250	0.14	13755	13553	0.13
	1986	7499	9735	0.46	7100	17386	0.52	15848	9855	0.28	9543	10549	0.13	15373	16412	0.24
	1989	4688	10330	0.41	10551	14952	0.35	22500	6540	0.29	11949	11490	0.11	16093	16747	0.11
	1992	16428	11786	0.41	7743	13746	0.43	10835	8630	0.27	10550	10292	0.12	14559	16081	0.10
Triennial- Late	1995	5056	5279	0.44	24285	26132	0.32	2713	2924	0.30	10225	11072	0.11	18373	18876	0.08
	1998	3714	3778	0.47	10372	11471	0.35	25545	21151	0.31	15211	14939	0.09	27979	30002	0.09
	2001	5716	3236	0.47	13550	14829	0.34	4414	5022	0.32	16414	17186	0.10	33135	34071	0.08
	2004	2935	6079	0.44	23448	25580	0.33	15232	17350	0.85	37733	34862	0.10	58815	61111	0.09
NWFSC	2003	19398	27362	0.39	164031	105706	0.48	26478	21205	0.47	38697	40260	0.14	56948	58250	0.09
	2004	28373	57970	0.62	21541	20414	0.51	16232	19239	0.55	46476	40948	0.13	54930	57759	0.12
	2005	28254	33980	0.38	21791	13061	0.50	21392	23343	0.43	33160	31870	0.12	51253	52654	0.09
	2006	13559	25856	0.43	5497	15287	0.96	9653	9036	0.47	20985	19478	0.13	48839	50359	0.10
	2007	14136	20347	0.44	2435	10176	0.59	25042	16089	0.44	17803	17713	0.13	45310	49885	0.10
	2008	20765	31124	0.43	3652	33992	0.93	12476	14247	0.47	14895	15061	0.12	35155	37580	0.09
	2009	18634	35855	0.31	7813	3452	0.62	9051	7320	0.47	16484	17286	0.13	35353	36509	0.10
	2010	8639	22998	0.32	782	3540	0.51	28723	37589	0.42	18387	18451	0.13	38564	40698	0.09
	2011	15304	40690	0.33	33482	17191	0.49	30516	25480	0.42	18554	20842	0.12	41530	44484	0.09
	2012	18722	27937	0.39	20594	18651	0.55	38715	14678	0.44	21296	20399	0.13	44622	47233	0.11

Table 26. Number of heat treatment samples by power station, over time. Plant acronyms are OBGS = Ormond Beach (Ventura), ESGS = El Segundo, RBGS = Redondo Beach, HBGS = Huntington Beach, SONGS = San Onofre Nuclear (San Clemente).

year	ESGS	HBGS	OBGS	RBGS	SONGS	ALL
1972	17	14			7	38
1973	14	13			8	35
1974	19	13		3	8	43
1975	21	12	4	5		42
1976	20	9	8	18	6	61
1977	21	10	9	3	7	50
1978	12	11	1	8	7	39
1979	16	10	11	12	6	55
1980	13	10	10	12	2	47
1981	14	11	9	10	4	48
1982	15	7	6	13	2	43
1983	10	7	6	12	9	44
1984	6	7	5	10	11	39
1985	12	7	6	13	15	53
1986	9	8	6	17	14	54
1987	9	5	7	9	18	48
1988	6	7	6	8	18	45
1989	3	6	7	7	18	41
1990	7	6	8	9	17	47
1991	5	3	6	8	22	44
1992	9	5	12	9	25	60
1993	5	8	6	10	18	47
1994	8	8	8	11	17	52
1995	5	6	5	8	15	39
1996	5	8	8	12	21	54
1997	9	7	5	12	13	46
1998	3	4	5	8	24	44
1999	3		7	2	19	31
2000	11	1	6	5	20	43
2001	4	3	7	20	18	52
2002	5	7	5	6	22	45
2003	4	7	4	2	20	37
2004	3	7	2	4	18	34
2005	2	4	1	4	24	35
2006	4	5		2	15	26
2007	3	5		1	25	34
2008	3	7		1	22	33
2009	2	3			22	27
2010	2	8			18	28
2011		5		1	25	31

Table 27. Number of samples positive for five of the most frequently occurring rockfish species.

year	bocaccio	brown	grass	olive	vermilion
1972	23	8	13	20	
1973	17	6	25	12	
1974	18	14	20	26	
1975	27	35	18	33	
1976	12	31	19	26	
1977	17	32	18	29	
1978	18	17	21	20	
1979	18	34	17	32	
1980	12	32	19	20	
1981	5	22	17	5	
1982	3	21	13	2	
1983		24	15	2	
1984	4	11	8	2	
1985	7	30	17	6	
1986	5	20	8	9	
1987		13	15	8	
1988	16	12	11	5	
1989	7	15	16	8	
1990	3	11	11	3	
1991	13	17	17	2	
1992	6	23	7	9	
1993	1	12	8	2	
1994		14	10	4	
1995	4	8	2	1	1
1996	4	13	4	1	
1997	2	6	1		
1998		4	2	1	
1999	10	5	1	1	8
2000	7	14	4	3	5
2001	2	11	4	2	
2002	8	9	4	1	2
2003	12	17	3	4	5
2004	4	12	4	3	2
2005	13	14	6		2
2006		13	4		4
2007	5	13	4		7
2008	5	13	4		8
2009	8	14	6		8
2010	14	8	9	1	5
2011	3	12	7	1	4

Table 28. Sample sizes (trips) by YEAR, COUNTY and REGION from the RecFIN Type 3 database. The shaded cells (Central, 1997-98) are unreliable and are not used.

			SOUTH								CENTRAL						CA/OR				NORTH				
COUNTY:	SAN DIEGO	ORANGE	LOS ANGELES	VENTURA	SANTA BARBARA	SAN LUIS OBISPO	MONTEREY	SANTA CRUZ	SAN MATEO	SAN FRANCISCO	ALAMEDA	CONTRA COSTA	MARIN	SONOMA	MENDOCINO	HUMBOLDT	DEL NORTE	CURRY	COOS	DOUGLAS	LANE	LINCOLN	TILLAMOOK	CLATSOP	
YEAR/FIPS	**73**	**59**	**37**	**111**	**83**	**79**	**53**	**87**	**81**	**75**	**1**	**13**	**41**	**97**	**45**	**23**	**15**	**15**	**11**	**19**	**39**	**41**	**57**	**7**	Total
1980	40	70	36	130	85	21	75	1	11				6	6	17			3	3			47	5		556
1981	78	144	65	98	85	10	23	2	13	3	1		8	13	7		1		2			37	1		591
1982	242	284	157	65	57	6	30	5	12		1		4	7	21	1		2	1			44	2		941
1983	276	219	257	83	57	7	39	12	9				3	4	15			4				32	6		1023
1984	173	207	254	103	28	32	103	41	7		6		7	7	12			4	19	8		32	19	2	1064
1985	198	170	156	74	26	57	152	43	35		11	4	5	21	19		2	6	17	4		32	13		1045
1986	83	156	197	80	25	58	85	34	16			8	6	11	10			5	14	4	1	25	11		829
1987	22	44	63	5	9	16	15		20		15	9	10	26	5	1	1	4	4			40	5		314
1988	22	33	85	79	16	28	28	6	25	2	12		9	27	1	1	2	4	5	5		66	9		465
1989	20	16	80	20		10	4	7	21		2	5	3		4	1		2	10			69			274
1993	50	126	219	37	33	14												10	16	2		100	7	1	615
1994	136	47	113	46	9	20												16	16	1	1	70	15		490
1995	31	19	32	19	7	17	10	5	8				5	5	6	5	1	17	25			72	7		291
1996	33	37	40	30	5	42	38	12	27		8		5	22	6	8	2	9	13			70	9		416
1997	28	19	32	15	1	58	34	15	23		12	6		45		1		20	19			82	17		427
1998	61	30	60	28	9	52	32	20	25	5	25		39	65	6	2		11	20	1		88	26		605
1999	56	35	81	36	7	24	27	19	42	2	23		11	23	5	2		14	17			99	24	1	548
2000	43	31	77	18	5	13	6	12	14	1	7		12	10	3			8	4			53	21		338
2001	35	28	59	21	6	8	10	14	27	7	7		10	5	7	10	1	5	8			47	15		330
2002	76	54	103	40	7	18	14	19	35	8	21		8	15	9			6	11	3		77	10	3	537
2003	78	65	135	42	7	21	25	19	25	7	20		14	16	10	20	3	3				12	1		523
Grand Total	1781	1834	2301	1069	484	532	750	286	395	35	171	32	165	328	163	52	13	153	224	28	2	1194	223	7	12222

Table 29. Least square means of GLM for brown rockfish, central area (RecFIN).

YEAR	Index	CV	YEAR	Index	CV
1980	0.1934	0.3904	1993	0.1453	0.7271
1981	0.0992	0.5265	1994	0.0364	0.8266
1983	1.0230	0.5901	1996	0.0848	0.2521
1984	0.1229	0.5696	1999	0.1369	0.5163
1985	0.1422	0.2374	2000	0.0957	0.4364
1986	0.3906	0.3029	2001	0.1154	0.2450
1987	0.2480	0.5568	2002	0.0620	0.2173
1988	0.3327	0.9358	2003	0.1604	0.2767
1989	0.0476	0.5289			

Table 30. Least square means of GLM for brown rockfish, southern area (RecFIN).

YEAR	Index	CV	YEAR	Index	CV
1980	0.0201	0.5233	1994	0.0128	0.8015
1981	0.0218	0.9573	1996	0.0039	0.7178
1982	0.0353	0.9598	1998	0.0079	0.4538
1983	0.0106	0.5297	1999	0.0192	0.5172
1984	0.0167	0.4477	2000	0.0221	0.6067
1985	0.0096	0.4137	2001	0.0448	0.5027
1986	0.0023	0.6843	2002	0.0192	0.4162
1988	0.0067	0.4893	2003	0.0302	0.5446

Table 31. Least square means of GLM for China rockfish, northern area (RecFIN).

YEAR	Index	CV	YEAR	Index	CV
1980	0.1014	0.515	1993	0.0437	0.3
1981	0.059	0.263	1994	0.0404	0.257
1982	0.0441	0.642	1995	0.0252	0.291
1983	0.0193	0.65	1996	0.0244	0.332
1984	0.0192	0.366	1997	0.0374	0.245
1985	0.06	0.373	1998	0.0277	0.222
1986	0.0242	0.533	1999	0.0423	0.179
1987	0.0684	0.47	2000	0.0431	0.272
1988	0.0407	0.29	2001	0.0138	0.464
1989	0.031	0.358	2002	0.0156	0.34
			2003	0.0271	0.472

Table 32. Least square means of GLM for China rockfish, central area (RecFIN).

YEAR	Index	CV	YEAR	Index	CV
1980	0.0327	0.404	1993	0.0143	0.630
1981	0.0498	0.748	1994	0.018	0.412
1983	0.0592	0.422	1995	0.1076	0.233
1984	0.0137	0.514	1996	0.0449	0.148
1985	0.0253	0.319	1999	0.0302	0.233
1986	0.0496	0.331	2000	0.0304	0.262
1987	0.0486	0.428	2001	0.0698	0.207
1988	0.0584	0.364	2002	0.0801	0.182
1989	0.0669	0.410	2003	0.0607	0.167

Table 33. Least square means of GLM for copper rockfish, southern area (RecFIN).

YEAR	Index	CV		YEAR	Index	CV
1980	0.084	0.400		1993	0.083	0.568
1981	0.049	0.388		1994	0.084	1.272
1982	0.029	0.684		1995	0.063	0.678
1983	0.111	0.664		1996	0.133	0.332
1984	0.095	0.467		1997	0.077	1.231
1985	0.045	0.444		1998	0.089	0.425
1986	0.083	0.484		1999	0.148	0.259
				2000	0.093	0.482
1988	0.163	0.676		2001	0.087	0.399
				2002	0.074	0.236
				2003	0.161	0.427

Table 34. Least square means of GLM for copper rockfish, north-central area (RecFIN).

YEAR	Index	CV
1980	0.034	0.460
1981	0.116	0.402
1982	0.044	0.475
1983	0.111	0.359
1984	0.128	0.473
1985	0.056	0.347
1986	0.098	0.222
1987	0.028	1.674
1988	0.028	0.371
1989	0.089	0.254
1993	0.060	0.286
1994	0.060	0.292
1995	0.021	0.498
1996	0.052	0.126
1997	0.048	0.316
1998	0.042	0.400
1999	0.051	0.154
2000	0.050	0.324
2001	0.041	0.222
2002	0.037	0.310
2003	0.025	0.211

Table 35. Central California onboard CPFV index for brown rockfish (data from historical and current CDFW sampling programs and CalPoly onboard sampling).

Year	Index	SD.log
1988	0.3424	0.2004
1989	0.3270	0.1804
1990	0.3766	0.3239
1991	0.4119	0.4553
1992	0.2678	0.1866
1993	0.2923	0.2559
1994	0.1912	0.2419
1995	0.3226	0.2386
1996	0.2602	0.2103
1997	0.1565	0.2008
1998	0.3721	0.1662
1999	0.1332	0.5135
2000		
2001	0.2061	0.2515
2002	0.0945	0.3410
2003	0.2814	0.1403
2004	0.3104	0.1298
2005	0.3096	0.1600
2006	0.5117	0.1272
2007	0.4439	0.1408
2008	0.2967	0.2035
2009	0.4162	0.1888
2010	0.3567	0.1168
2011	0.3170	0.1334

Table 36. Central California onboard CPFV index for China rockfish (data from historical and current CDFW sampling programs and CalPoly onboard sampling).

Year	index	log.sd
1988	0.0512	0.1690
1989	0.0520	0.1682
1990	0.1170	0.2245
1991	0.0733	0.2932
1992	0.0409	0.1751
1993	0.0461	0.1860
1994	0.0731	0.1473
1995	0.0456	0.1906
1996	0.0522	0.1574
1997	0.0375	0.1885
1998	0.0186	0.2281
1999	0.0429	0.2935
2000		
2001	0.0328	0.2732
2002	0.0544	0.2677
2003	0.0671	0.1840
2004	0.0594	0.1672
2005	0.0565	0.2367
2006	0.0518	0.2139
2007	0.0737	0.1828
2008	0.0674	0.1927
2009	0.1014	0.1778
2010	0.0878	0.1710
2011	0.0640	0.1658

Table 37. Central California onboard CPFV index for copper rockfish (data from historical and current CDFW sampling programs and CalPoly onboard sampling).

Year	index	log.sd
1988	0.0397	0.1416
1989	0.0597	0.1187
1990	0.0724	0.2005
1991	0.0468	0.2232
1992	0.0686	0.1207
1993	0.0697	0.1254
1994	0.0495	0.1329
1995	0.0603	0.1252
1996	0.0576	0.1208
1997	0.0604	0.1269
1998	0.0552	0.1518
1999	0.0403	0.4086
2000		
2001	0.1001	0.2187
2002	0.0545	0.3742
2003	0.0736	0.1990
2004	0.0939	0.1175
2005	0.1555	0.1235
2006	0.1497	0.1104
2007	0.1309	0.1166
2008	0.0764	0.1636
2009	0.0705	0.1786
2010	0.1370	0.1126
2011	0.1029	0.1239

Table 38. Least square means of the delta-GLM for brown rockfish, southern area (CDFW Observer Program).

Year	Index	CV
1999	0.0089	0.377
2000	0.0055	0.419
2001	0.0079	0.403
2002	0.0229	0.213
2003	0.0299	0.205
2004	0.0193	0.245
2005	0.0366	0.166
2006	0.0857	0.124
2007	0.0550	0.139
2008	0.0815	0.120
2009	0.0647	0.109
2010	0.0826	0.113
2011	0.0577	0.154

Table 39. Least square means of the delta-GLM for copper rockfish, southern area (CDFW Observer Program).

Year	Index	CV
1999	0.0347	0.205
2000	0.0483	0.280
2001	0.0103	0.387
2002	0.0167	0.258
2003	0.0429	0.183
2004	0.0253	0.197
2005	0.0567	0.164
2006	0.0655	0.128
2007	0.1051	0.105
2008	0.0848	0.098
2009	0.0611	0.121
2010	0.0553	0.110
2011	0.0815	0.096

Table 40. Least square means of the delta-GLM for China rockfish, northern area (ODFW Observer Program).

Year	Index	CV
2001	0.0341	0.241
2002		
2003	0.0306	0.220
2004	0.0205	0.332
2005	0.0154	0.345
2006	0.0189	0.276
2007	0.0369	0.199
2008	0.0178	0.274
2009	0.0300	0.242
2010	0.0081	0.542
2011	0.0236	0.439
2012	0.0334	0.262

Table 41. Least square means of the delta-GLM for copper rockfish, northern area (ODFW Observer Program).

Year	Index	CV
2001	0.0264	0.350
2002		
2003	0.0147	0.369
2004	0.0118	0.423
2005	0.0387	0.308
2006	0.0384	0.261
2007	0.0304	0.237
2008	0.0149	0.324
2009	0.0316	0.290
2010	0.0406	0.304
2011	0.0137	0.513
2012	0.0230	0.365

Table 42. Sex-specific priors for natural mortality (*M*) calculated from Hamel's method and used in exSSS sensitivity runs. M is given in normal space, but the prior is lognormal, with SD log the standard deviation in log space.

		Females		Males	
Group	Species	*M*	SD log	*M*	SD log
Rockfishes	Brown	0.17	0.41	0.18	0.41
	China	0.12	0.41	0.12	0.41
	Copper	0.16	0.30	0.14	0.41
	Sharpchin	0.13	0.41	0.14	0.41
	Stripetail	0.17	0.41	0.21	0.41
	Yellowtail N	0.14	0.30	0.11	0.41
Flatfishes	English sole	0.33	0.26	0.41	0.33
	Rex sole	0.31	0.33	0.31	0.33

7.2 Model results

7.2.1 XBD-SRA model estimates

Table 43. Derived quantities from DB-SRA and XDB-SRA for three species of nearshore rockfishes. Parentheses contain the range of the 95% credibility intervals. * OFL estimates for Copper rockfish North and South of 40°10′ N. lat. are a post-stratification of assessment results based on cumulative removals by area, 1916-2012.

	DB-SRA (catch-based) estimates							
Stock	SB_0	SB_{2013}	SB_{2013} / SB_0	SB_{MSY}	F_{2012} / F_{MSY}	MSY	OFL_{2015}	OFL_{2016}
Brown rockfish (Coastwide)	2046 (880 - 5697)	784 (56 - 3920)	0.42 (0.03 - 0.88)	818 (352 - 2279)	0.67 (0.19 - 10.18)	145 (63 - 253)	151 (1 - 513)	149 (0 - 508)
China rockfish (N. of 40°10' N. lat.)	225 (116 - 614)	57 (2 - 448)	0.27 (0.01 - 0.79)	90 (46 - 245)	3.46 (0.39 - 38.92)	8 (2 - 23)	4 (0 - 44)	4 (0 - 45)
China rockfish (S. of 40°10' N. lat.)	624 (276 - 1722)	199 (10 - 1250)	0.35 (0.02 - 0.85)	249 (111 - 689)	0.85 (0.14 - 16.34)	21 (7 - 48)	17 (0 - 98)	15 (0 - 96)
Copper rockfish (N. of 34°27' N. lat.)	2023 (965 - 5388)	787 (53 - 3904)	0.41 (0.03 - 0.92)	809 (386 - 2155)	0.48 (0.11 - 8.03)	100 (36 - 188)	100 (3 - 422)	97 (0 - 409)
Copper rockfish (S. of 34°27' N. lat.)	1110 (576 - 2886)	423 (27 - 2116)	0.4 (0.03 - 0.9)	444 (230 - 1154)	0.98 (0.2 - 14.37)	56 (19 - 112)	52 (1 - 244)	46 (0 - 226)

	XDB-SRA estimates							
Stock	SB_0	SB_{2013}	SB_{2013} / SB_0	SB_{MSY}	F_{2012} / F_{MSY}	MSY	OFL_{2015}	OFL_{2016}
Brown rockfish (Coastwide)	1794 (977 - 3732)	727 (333 - 2285)	0.42 (0.22 - 0.77)	718 (391 - 1493)	0.63 (0.27 - 1.47)	149 (109 - 196)	166 (69 - 364)	162 (66 - 361)
China rockfish (N. of 40°10' N. lat.)	243 (127 - 542)	84 (22 - 366)	0.37 (0.12 - 0.73)	97 (51 - 217)	2.15 (0.49 - 11.29)	9 (3 - 20)	7 (1 - 35)	7 (1 - 36)
China rockfish (S. of 40°10' N. lat.)	405 (232 - 1272)	264 (138 - 925)	0.66 (0.4 - 0.93)	162 (93 - 509)	0.27 (0.13 - 0.58)	32 (22 - 50)	55 (25 - 108)	53 (23 - 104)
Copper rockfish (N. of 34°27' N. lat.)	1704 (1081 - 2734)	795 (417 - 1694)	0.48 (0.26 - 0.85)	681 (433 - 1093)	0.34 (0.15 - 0.87)	114 (75 - 148)	145 (56 - 314)	141 (52 - 308)
Copper rockfish (S. of 34°27' N. lat.)	942 (545 - 2745)	699 (351 - 2189)	0.76 (0.43 - 0.99)	377 (218 - 1098)	0.32 (0.16 - 0.86)	84 (51 - 136)	167 (59 - 303)	154 (54 - 287)
Copper rockfish (N. of 40°10' N. lat.)							11*	10*
Copper rockfish (S. of 40°10' N. lat.)							301*	284*

7.2.1.1 Brown rockfish

Table 44. Time series from the XDB-SRA model for brown rockfish. Derived quantities (biomasses, depletion, and exploitation rates) are median values. Catch is total catch (landings + discard).

Year	Catch	Vulnerable Biomass	Spawning Biomass	Depletion	Exploitation Rate	Exp. Rate / Emsy
1916	9.2	3588.2	1794.1	1.000	0.003	0.024
1917	14.3	3579.0	1789.5	0.997	0.004	0.037
1918	16.7	3565.8	1782.9	0.994	0.005	0.044
1919	11.6	3551.8	1775.9	0.990	0.003	0.030
1920	11.9	3545.2	1772.6	0.988	0.003	0.031
1921	9.8	3539.2	1769.6	0.986	0.003	0.026
1922	8.4	3536.1	1768.0	0.985	0.002	0.022
1923	9.1	3536.1	1768.1	0.985	0.003	0.024
1924	5.3	3535.2	1767.6	0.985	0.001	0.014
1925	7.6	3537.7	1768.9	0.986	0.002	0.020
1926	9.6	3536.8	1768.4	0.986	0.003	0.025
1927	4.3	3534.1	1767.0	0.985	0.001	0.011
1928	5.7	3536.7	1768.4	0.986	0.002	0.015
1929	5.4	3537.6	1768.8	0.986	0.002	0.014
1930	10.5	3538.0	1769.0	0.986	0.003	0.027
1931	13.8	3533.2	1766.6	0.985	0.004	0.036
1932	14.3	3526.1	1763.1	0.983	0.004	0.038
1933	15.8	3519.4	1759.7	0.981	0.004	0.042
1934	11.2	3511.8	1755.9	0.979	0.003	0.030
1935	14.4	3508.9	1754.4	0.979	0.004	0.038
1936	15.0	3503.1	1751.6	0.978	0.004	0.040
1937	17.0	3498.6	1749.3	0.977	0.005	0.045
1938	18.3	3493.1	1746.6	0.975	0.005	0.049
1939	20.1	3486.2	1743.1	0.973	0.006	0.054
1940	22.3	3478.0	1739.0	0.971	0.006	0.060
1941	22.0	3468.5	1734.2	0.969	0.006	0.059
1942	6.7	3460.1	1730.0	0.967	0.002	0.018
1943	8.7	3468.2	1734.1	0.969	0.003	0.023
1944	5.6	3473.3	1736.6	0.971	0.002	0.015
1945	12.2	3479.5	1739.8	0.973	0.004	0.033
1946	23.0	3479.8	1739.9	0.973	0.007	0.061
1947	14.0	3469.2	1734.6	0.970	0.004	0.037
1948	22.5	3468.9	1734.5	0.970	0.006	0.060
1949	29.8	3459.9	1730.0	0.968	0.009	0.080
1950	30.2	3444.6	1722.3	0.964	0.009	0.081
1951	46.1	3430.4	1715.2	0.960	0.013	0.124
1952	46.6	3402.2	1701.1	0.951	0.014	0.127
1953	37.1	3376.4	1688.2	0.944	0.011	0.102
1954	50.9	3364.4	1682.2	0.941	0.015	0.140
1955	99.2	3339.5	1669.8	0.934	0.030	0.275
1956	106.3	3270.8	1635.4	0.915	0.032	0.302
1957	108.6	3204.3	1602.1	0.896	0.034	0.315
1958	129.4	3142.9	1571.5	0.879	0.041	0.383
1959	91.0	3069.0	1534.5	0.858	0.030	0.276
1960	106.3	3038.6	1519.3	0.851	0.035	0.326
1961	85.3	3000.3	1500.1	0.841	0.028	0.264
1962	92.2	2985.4	1492.7	0.838	0.031	0.287
1963	116.4	2966.5	1483.2	0.833	0.039	0.364
1964	94.2	2924.8	1462.4	0.822	0.032	0.298

Table 44. (Continued). Time series from the XDB-SRA model for brown rockfish. Derived quantities (biomasses, depletion, and exploitation rates) are median values. Catch is total catch (landings + discard).

Year	Catch	Vulnerable Biomass	Spawning Biomass	Depletion	Exploitation Rate	Exp. Rate / Emsy
1965	119.6	2910.3	1455.1	0.818	0.041	0.380
1966	136.2	2871.4	1435.7	0.807	0.047	0.438
1967	150.3	2814.8	1407.4	0.793	0.053	0.493
1968	156.4	2750.8	1375.4	0.776	0.057	0.526
1969	126.9	2688.2	1344.1	0.760	0.047	0.436
1970	161.5	2662.0	1331.0	0.753	0.061	0.559
1971	161.2	2601.5	1300.8	0.737	0.062	0.571
1972	212.7	2547.4	1273.7	0.723	0.084	0.769
1973	310.4	2447.8	1223.9	0.695	0.127	1.170
1974	360.0	2263.7	1131.9	0.642	0.159	1.484
1975	313.7	2044.4	1022.2	0.580	0.153	1.451
1976	334.4	1901.9	951.0	0.540	0.176	1.677
1977	284.8	1749.8	874.9	0.497	0.163	1.562
1978	202.7	1652.9	826.4	0.471	0.123	1.180
1979	196.3	1635.1	817.6	0.468	0.120	1.147
1980	412.8	1612.2	806.1	0.464	0.256	2.424
1981	141.2	1359.4	679.7	0.390	0.104	0.997
1982	260.3	1399.0	699.5	0.404	0.186	1.769
1983	139.6	1314.0	657.0	0.382	0.106	1.004
1984	237.2	1359.5	679.8	0.397	0.174	1.623
1985	217.6	1264.2	632.1	0.370	0.172	1.605
1986	267.1	1209.6	604.8	0.355	0.221	2.052
1987	190.2	1105.0	552.5	0.324	0.172	1.607
1988	319.6	1098.2	549.1	0.323	0.291	2.696
1989	213.3	947.4	473.7	0.279	0.225	2.108
1990	172.9	912.2	456.1	0.269	0.190	1.767
1991	170.4	904.8	452.4	0.267	0.188	1.752
1992	142.1	901.7	450.8	0.267	0.158	1.461
1993	137.8	902.3	451.1	0.265	0.153	1.423
1994	76.1	900.1	450.1	0.264	0.085	0.789
1995	76.6	957.4	478.7	0.281	0.080	0.743
1996	106.8	1007.5	503.8	0.296	0.106	0.983
1997	154.3	1020.6	510.3	0.299	0.151	1.402
1998	98.3	982.0	491.0	0.287	0.100	0.928
1999	125.8	1017.2	508.6	0.298	0.124	1.144
2000	101.5	1030.3	515.1	0.302	0.099	0.910
2001	151.8	1070.0	535.0	0.313	0.142	1.311
2002	94.5	1046.4	523.2	0.304	0.090	0.838
2003	169.3	1086.5	543.3	0.316	0.156	1.442
2004	58.2	1049.2	524.6	0.305	0.055	0.512
2005	100.4	1138.3	569.1	0.331	0.088	0.810
2006	89.2	1168.1	584.1	0.339	0.076	0.700
2007	76.1	1214.0	607.0	0.350	0.063	0.578
2008	72.6	1258.4	629.2	0.363	0.058	0.530
2009	84.9	1318.2	659.1	0.379	0.064	0.591
2010	97.0	1361.4	680.7	0.391	0.071	0.651
2011	112.7	1393.4	696.7	0.399	0.081	0.736
2012	94.7	1412.7	706.4	0.404	0.067	0.610
2013	101.5	1454.3	727.2	0.417	0.070	0.630

Table 45. Percentiles of estimated parameters and derived quantities from the XDB-SRA model for brown rockfish (coastwide). OFL estimates after 2013 assume projections of constant catch, equal to average catch from 2010-2012.

		Percentile				
Quantity	**Derived or Estimated**	**5%**	**25%**	**50%**	**75%**	**95%**
log q (index 1)	Derived	-9.257	-8.580	-8.188	-7.849	-7.411
log q (index 2)	Derived	-11.535	-10.871	-10.487	-10.143	-9.715
log q (index 3)	Derived	-10.052	-9.387	-9.015	-8.709	-8.313
log q (index 4)	Derived	-12.361	-11.704	-11.336	-11.033	-10.640
log a (index 1)	Estimated	-3.703	-3.056	-2.649	-2.286	-1.786
log a (index 2)	Estimated	-1.021	-0.537	-0.201	0.149	0.689
log a (index 3)	Estimated	-2.375	-1.592	-1.117	-0.703	-0.163
log a (index 4)	Estimated	-2.693	-1.545	-0.954	-0.490	0.121
M	Estimated	0.074	0.104	0.133	0.170	0.243
F_{MSY} / M	Estimated	0.532	0.764	0.971	1.209	1.687
Delta (year: 2000)	Estimated	0.440	0.612	0.698	0.767	0.833
B_{MSY} / B_0	Estimated	0.221	0.318	0.399	0.483	0.609
F_{MSY}	Derived	0.066	0.101	0.130	0.165	0.236
E_{MSY}	Derived	0.060	0.091	0.114	0.141	0.191
MSY	Derived	124.1	141.5	155.7	170.5	197.9
B_{MSY}	Derived	848.6	1120.9	1383.4	1694.4	2463.8
Vulnerable Biomass (1916)	Derived	2194.4	2918.0	3588.2	4368.4	6254.6
Vulnerable Biomass (2015)	Derived	811.6	1143.2	1523.7	2081.9	3632.5
OFL 2015	Derived	101.6	136.3	170.9	217.2	350.6

Table 46. Sensitivity analyses for brown rockfish (coastwide) presented at the STAR Panel. Results are not based on the final (base) model. 'oldBase' uses productivity priors from Dick and MacCall (2010), 'Zhou' uses diffuse priors for F_{MSY}/M and B_{MSY}/B_0 (see text for details), and runs starting with 'Z-' are the 'Zhou' run fit to single indices of abundance.

Run	SB_0	SB_{2013}	SB_{2013}/SB_0	F_{2012}/F_{MSY}	OFL_{2015}	OFL_{2016}
oldBase	1839.1 (1279.8 - 2853.3)	570.5 (326.9 - 1344.3)	0.32 (0.21 - 0.54)	0.81 (0.45 - 1.3)	123.9 (78.6 - 217.5)	126.2 (79.5 - 221.1)
Zhou	1791.4 (1139.5 - 2853.7)	507.8 (287 - 1312.8)	0.3 (0.17 - 0.57)	0.77 (0.41 - 1.23)	132.8 (84.4 - 236.2)	136.2 (85.5 - 241.6)
Z-CenCalObsOnly	2321.8 (1389 - 5753.4)	1007.1 (381.3 - 4071.1)	0.45 (0.22 - 0.81)	0.57 (0.15 - 1.15)	171.9 (87.5 - 613)	175 (88.2 - 614.7)
Z-SoCalObsOnly	1787.9 (779.2 - 105112)	770.8 (320.8 - 97210.3)	0.53 (0.19 - 0.97)	0.35 (0 - 1.38)	279.4 (71.5 - 13940.9)	286.3 (71.4 - 13044.9)
Z-RecFINONly	2370.8 (1216.8 - 4298.7)	431.2 (146.6 - 1666.2)	0.2 (0.07 - 0.51)	1.4 (0.39 - 5.39)	71 (14.3 - 241.8)	70.7 (11.7 - 246.2)

7.2.1.2 China rockfish

7.2.1.2.1 North of 40° 10′ N lat.

Table 47. Time series from the XDB-SRA model for China rockfish (north of 40° 10′ N lat.). Derived quantities (biomasses, depletion, and exploitation rates) are median values. Catch is total catch (landings + discard).

Year	Catch	Vulnerable Biomass	Spawning Biomass	Depletion	Exploitation Rate	Exp. Rate / Emsy
1916	0.0	486.0	243.0	1.000	0.000	0.000
1917	0.0	486.0	243.0	1.000	0.000	0.000
1918	0.0	486.0	243.0	1.000	0.000	0.000
1919	0.0	486.0	243.0	1.000	0.000	0.000
1920	0.0	486.0	243.0	1.000	0.000	0.000
1921	0.0	486.0	243.0	1.000	0.000	0.000
1922	0.0	486.0	243.0	1.000	0.000	0.000
1923	0.0	486.0	243.0	1.000	0.000	0.000
1924	0.0	486.0	243.0	1.000	0.000	0.000
1925	0.0	486.0	243.0	1.000	0.000	0.000
1926	0.0	486.0	243.0	1.000	0.000	0.000
1927	0.0	486.0	243.0	1.000	0.000	0.000
1928	0.0	486.0	243.0	1.000	0.000	0.001
1929	0.1	486.0	243.0	1.000	0.000	0.003
1930	0.1	485.9	243.0	1.000	0.000	0.005
1931	0.1	485.8	242.9	0.999	0.000	0.003
1932	0.0	485.7	242.9	0.999	0.000	0.002
1933	0.1	485.7	242.9	0.999	0.000	0.004
1934	0.8	485.6	242.8	0.999	0.002	0.032
1935	0.6	484.9	242.4	0.998	0.001	0.026
1936	1.0	484.3	242.2	0.996	0.002	0.042
1937	0.8	483.4	241.7	0.995	0.002	0.034
1938	2.6	482.7	241.4	0.993	0.005	0.107
1939	4.7	480.4	240.2	0.988	0.010	0.198
1940	3.0	475.9	237.9	0.979	0.006	0.127
1941	1.0	473.4	236.7	0.974	0.002	0.042
1942	0.8	473.3	236.7	0.974	0.002	0.036
1943	0.4	473.1	236.6	0.973	0.001	0.017
1944	0.4	473.4	236.7	0.974	0.001	0.018
1945	0.5	473.6	236.8	0.975	0.001	0.021
1946	0.6	473.7	236.8	0.976	0.001	0.024
1947	0.3	473.7	236.9	0.976	0.001	0.011
1948	0.5	474.1	237.0	0.977	0.001	0.019
1949	0.4	474.2	237.1	0.978	0.001	0.018
1950	0.3	474.4	237.2	0.978	0.001	0.012
1951	0.3	474.6	237.3	0.979	0.001	0.011
1952	0.3	474.8	237.4	0.980	0.001	0.013
1953	0.1	475.0	237.5	0.980	0.000	0.006
1954	0.1	475.4	237.7	0.981	0.000	0.005
1955	0.2	475.8	237.9	0.982	0.001	0.010
1956	0.2	476.2	238.1	0.983	0.000	0.007
1957	0.4	476.5	238.2	0.983	0.001	0.015
1958	0.1	476.7	238.3	0.983	0.000	0.005
1959	0.1	476.9	238.5	0.984	0.000	0.006
1960	0.1	477.2	238.6	0.985	0.000	0.005
1961	0.3	477.6	238.8	0.985	0.001	0.012
1962	0.3	477.6	238.8	0.985	0.001	0.013
1963	0.5	477.6	238.8	0.986	0.001	0.020
1964	0.5	477.6	238.8	0.986	0.001	0.022

Table 47 (Continued). Time series from the XDB-SRA model for China rockfish (north of 40° 10′ N lat.). Derived quantities (biomasses, depletion, and exploitation rates) are median values. Catch is total catch (landings + discard).

Year	Catch	Vulnerable Biomass	Spawning Biomass	Depletion	Exploitation Rate	Exp. Rate / Emsy
1965	0.9	477.4	238.7	0.985	0.002	0.039
1966	0.9	476.9	238.4	0.984	0.002	0.039
1967	1.4	476.3	238.1	0.983	0.003	0.060
1968	1.5	475.3	237.6	0.981	0.003	0.064
1969	2.5	474.2	237.1	0.979	0.005	0.105
1970	2.0	472.3	236.2	0.974	0.004	0.086
1971	3.0	471.1	235.5	0.971	0.006	0.126
1972	3.5	468.8	234.4	0.966	0.008	0.150
1973	4.5	466.1	233.0	0.960	0.010	0.193
1974	5.7	462.7	231.3	0.952	0.012	0.248
1975	4.2	458.1	229.1	0.943	0.009	0.181
1976	5.0	455.5	227.7	0.937	0.011	0.218
1977	5.2	452.2	226.1	0.930	0.012	0.231
1978	7.2	448.7	224.4	0.924	0.016	0.319
1979	9.9	443.5	221.7	0.913	0.022	0.447
1980	10.7	435.8	217.9	0.897	0.024	0.490
1981	10.4	428.0	214.0	0.881	0.024	0.487
1982	10.6	420.6	210.3	0.866	0.025	0.505
1983	9.1	413.6	206.8	0.851	0.022	0.439
1984	8.9	408.6	204.3	0.841	0.022	0.434
1985	6.9	403.6	201.8	0.831	0.017	0.341
1986	7.3	400.9	200.4	0.828	0.018	0.364
1987	8.7	397.9	199.0	0.823	0.022	0.433
1988	7.9	393.2	196.6	0.815	0.020	0.400
1989	11.9	389.6	194.8	0.810	0.030	0.603
1990	17.6	382.2	191.1	0.795	0.046	0.911
1991	10.4	369.8	184.9	0.769	0.028	0.556
1992	15.6	364.7	182.4	0.760	0.043	0.846
1993	12.6	354.7	177.3	0.741	0.036	0.703
1994	17.5	349.1	174.5	0.728	0.050	0.992
1995	18.0	337.7	168.9	0.706	0.053	1.051
1996	15.8	326.4	163.2	0.683	0.048	0.950
1997	22.0	318.0	159.0	0.666	0.069	1.362
1998	27.3	303.0	151.5	0.637	0.090	1.775
1999	35.5	283.6	141.8	0.596	0.125	2.482
2000	22.0	257.3	128.7	0.539	0.086	1.713
2001	28.0	245.4	122.7	0.515	0.114	2.275
2002	29.0	227.9	113.9	0.479	0.127	2.547
2003	16.5	210.4	105.2	0.441	0.078	1.576
2004	12.0	205.6	102.8	0.434	0.058	1.166
2005	9.4	205.2	102.6	0.433	0.046	0.915
2006	11.1	206.2	103.1	0.437	0.054	1.061
2007	15.4	204.3	102.1	0.436	0.075	1.478
2008	16.3	197.7	98.8	0.423	0.082	1.616
2009	15.1	190.5	95.3	0.409	0.079	1.554
2010	11.8	184.5	92.3	0.398	0.064	1.255
2011	16.4	182.1	91.1	0.395	0.090	1.750
2012	17.3	175.9	88.0	0.382	0.099	1.921
2013	15.2	168.2	84.1	0.367	0.090	1.757

Table 48. Percentiles of estimated parameters and derived quantities from the XDB-SRA model for China rockfish (north of 40° 10′ N lat.). OFL estimates assume projections of constant catch, equal to average catch from 2010-2012.

		Percentile				
Quantity	**Derived or Estimated**	**5%**	**25%**	**50%**	**75%**	**95%**
log q (index 1)	Derived	-9.970	-9.429	-9.168	-8.902	-8.561
log q (index 2)	Derived	-10.160	-9.468	-9.085	-8.728	-8.271
log a (index 1)	Estimated	-4.635	-3.336	-2.712	-2.173	-1.512
log a (index 2)	Estimated	-3.962	-2.669	-1.987	-1.386	-0.621
M	Estimated	0.030	0.044	0.058	0.075	0.108
F_{MSY} / M	Estimated	0.431	0.678	0.916	1.271	1.931
Delta (year: 2000)	Estimated	0.265	0.387	0.461	0.517	0.585
B_{MSY} / B_0	Estimated	0.195	0.298	0.381	0.475	0.605
F_{MSY}	Derived	0.019	0.035	0.054	0.080	0.136
E_{MSY}	Derived	0.019	0.034	0.051	0.074	0.122
MSY	Derived	3.82	6.78	9.48	12.22	17.98
B_{MSY}	Derived	99.2	138.2	178.7	230.6	347.6
Vulnerable Biomass (1916)	Derived	280.6	388.0	486.0	599.6	910.8
Vulnerable Biomass (2015)	Derived	43.7	98.7	157.9	257.0	539.1
OFL 2015	Derived	1.62	4.58	8.13	14.12	30.19

Table 49. Sensitivity analyses for China rockfish (north of 40° 10′ N lat.) presented at the STAR Panel. Results are not based on the final (base) model. 'oldBase' uses productivity priors from Dick and MacCall (2010), 'Zhou' uses diffuse priors for F_{MSY}/M and B_{MSY}/B (see text for details), and runs starting with 'Z-' are the 'Zhou' run fit to single indices of abundance.

Run	SB0	SB2013	SB2013/SB0	F2012/FMSY	OFL2015	OFL2016
oldBase	231 (154.9 - 397.2)	80.6 (28.9 - 249.2)	0.36 (0.16 - 0.65)	2.37 (0.75 - 6.98)	6.7 (1.7 - 22.4)	6.4 (1.4 - 22.3)
Zhou	227.4 (131 - 404.2)	80.6 (28.5 - 250.6)	0.37 (0.16 - 0.67)	2.06 (0.57 - 7.53)	7.7 (1.7 - 29.2)	7.4 (1.3 - 29.1)
Z-NorCalORObsOnly	237.1 (128.5 - 533.7)	89.8 (25.7 - 379)	0.4 (0.15 - 0.78)	1.87 (0.41 - 7.13)	8.5 (1.7 - 41.3)	8.3 (1.3 - 41.3)
Z-RecFINOnly	221.7 (133 - 396.5)	66.8 (22.5 - 240.2)	0.32 (0.12 - 0.67)	2.63 (0.6 - 10.02)	5.8 (1 - 27.9)	5.5 (0.7 - 27.7)

7.2.1.2.2 South of 40° 10′ N lat.

Table 50. Time series from the XDB-SRA model for China rockfish (south of 40° 10′ N lat.). Derived quantities (biomasses, depletion, and exploitation rates) are median values. Catch is total catch (landings + discard).

Year	Catch	Vulnerable Biomass	Spawning Biomass	Depletion	Exploitation Rate	Exp. Rate / Emsy
1916	6.5	811.0	405.5	1.000	0.008	0.087
1917	10.1	804.4	402.2	0.992	0.013	0.136
1918	11.9	794.8	397.4	0.980	0.015	0.161
1919	8.2	783.9	392.0	0.967	0.011	0.114
1920	8.4	777.4	388.7	0.959	0.011	0.117
1921	6.9	771.1	385.5	0.952	0.009	0.098
1922	6.0	767.5	383.8	0.947	0.008	0.084
1923	6.5	765.8	382.9	0.945	0.008	0.091
1924	3.7	764.4	382.2	0.944	0.005	0.053
1925	4.7	767.6	383.8	0.948	0.006	0.066
1926	7.5	768.7	384.3	0.951	0.010	0.106
1927	6.4	767.6	383.8	0.950	0.008	0.090
1928	8.2	768.6	384.3	0.950	0.011	0.115
1929	7.2	765.9	383.0	0.948	0.009	0.102
1930	10.0	765.6	382.8	0.948	0.013	0.141
1931	5.1	761.8	380.9	0.943	0.007	0.073
1932	11.5	763.4	381.7	0.945	0.015	0.162
1933	5.5	758.0	379.0	0.939	0.007	0.078
1934	10.1	758.5	379.2	0.940	0.013	0.143
1935	9.5	755.2	377.6	0.935	0.013	0.136
1936	9.8	752.8	376.4	0.932	0.013	0.141
1937	9.6	750.1	375.1	0.928	0.013	0.138
1938	7.7	748.1	374.1	0.926	0.010	0.111
1939	5.4	748.4	374.2	0.926	0.007	0.078
1940	5.5	751.0	375.5	0.930	0.007	0.080
1941	5.1	753.4	376.7	0.934	0.007	0.073
1942	2.8	756.7	378.4	0.937	0.004	0.040
1943	3.8	761.7	380.8	0.943	0.005	0.054
1944	2.1	765.2	382.6	0.947	0.003	0.030
1945	2.7	770.2	385.1	0.952	0.004	0.038
1946	5.3	774.4	387.2	0.957	0.007	0.073
1947	4.6	775.2	387.6	0.958	0.006	0.063
1948	9.4	776.2	388.1	0.959	0.012	0.130
1949	12.4	772.0	386.0	0.954	0.016	0.173
1950	11.3	764.0	382.0	0.945	0.015	0.160
1951	13.8	757.8	378.9	0.936	0.018	0.197
1952	12.1	749.7	374.9	0.924	0.016	0.175
1953	10.6	743.5	371.7	0.916	0.014	0.154
1954	11.0	739.4	369.7	0.911	0.015	0.162
1955	12.6	736.0	368.0	0.907	0.017	0.186
1956	13.9	732.1	366.1	0.902	0.019	0.207
1957	14.2	727.5	363.7	0.897	0.019	0.211
1958	22.7	723.2	361.6	0.893	0.031	0.341
1959	18.1	712.1	356.1	0.880	0.025	0.276
1960	15.1	705.3	352.6	0.873	0.021	0.232
1961	14.7	703.4	351.7	0.871	0.021	0.227
1962	12.6	702.2	351.1	0.869	0.018	0.194
1963	16.0	702.7	351.3	0.871	0.023	0.246
1964	10.1	700.5	350.3	0.868	0.014	0.156

Table 50 (Continued). Time series from the XDB-SRA model for China rockfish (south of 40° 10′ N lat.). Derived quantities (biomasses, depletion, and exploitation rates) are median values. Catch is total catch (landings + discard).

Year	Catch	Vulnerable Biomass	Spawning Biomass	Depletion	Exploitation Rate	Exp. Rate / Emsy
1965	17.0	703.6	351.8	0.873	0.024	0.261
1966	18.9	700.4	350.2	0.870	0.027	0.291
1967	24.3	696.6	348.3	0.865	0.035	0.377
1968	21.1	687.0	343.5	0.853	0.031	0.333
1969	23.2	681.3	340.7	0.846	0.034	0.368
1970	37.3	673.3	336.7	0.836	0.055	0.601
1971	27.1	651.5	325.7	0.808	0.042	0.452
1972	39.2	641.4	320.7	0.795	0.061	0.665
1973	50.3	620.3	310.1	0.769	0.081	0.883
1974	49.5	590.6	295.3	0.731	0.084	0.920
1975	48.0	563.4	281.7	0.697	0.085	0.938
1976	52.1	541.3	270.7	0.670	0.096	1.061
1977	47.8	515.8	257.9	0.639	0.093	1.025
1978	33.3	497.0	248.5	0.617	0.067	0.741
1979	44.4	495.3	247.6	0.616	0.090	0.991
1980	59.2	481.0	240.5	0.601	0.123	1.362
1981	36.3	453.9	226.9	0.567	0.080	0.890
1982	47.0	451.7	225.9	0.565	0.104	1.155
1983	24.2	438.0	219.0	0.548	0.055	0.616
1984	25.0	448.2	224.1	0.563	0.056	0.616
1985	30.6	456.4	228.2	0.574	0.067	0.738
1986	43.9	457.7	228.9	0.576	0.096	1.055
1987	59.3	445.2	222.6	0.560	0.133	1.468
1988	42.9	417.9	209.0	0.525	0.103	1.139
1989	38.3	409.0	204.5	0.514	0.094	1.039
1990	36.4	405.9	203.0	0.511	0.090	0.993
1991	40.4	404.3	202.2	0.510	0.100	1.104
1992	49.3	399.9	199.9	0.504	0.123	1.364
1993	41.7	384.2	192.1	0.484	0.108	1.203
1994	61.9	375.8	187.9	0.475	0.165	1.820
1995	46.6	350.1	175.0	0.440	0.133	1.484
1996	33.9	340.8	170.4	0.427	0.100	1.114
1997	39.0	345.0	172.5	0.431	0.113	1.265
1998	19.0	342.1	171.0	0.427	0.056	0.622
1999	21.2	358.3	179.1	0.447	0.059	0.660
2000	20.6	369.4	184.7	0.461	0.056	0.617
2001	19.1	379.4	189.7	0.470	0.050	0.558
2002	18.1	390.4	195.2	0.484	0.046	0.511
2003	17.6	401.3	200.7	0.496	0.044	0.480
2004	9.9	413.0	206.5	0.511	0.024	0.262
2005	15.9	433.1	216.6	0.534	0.037	0.400
2006	12.8	445.1	222.6	0.550	0.029	0.313
2007	13.5	460.7	230.3	0.570	0.029	0.318
2008	15.3	475.7	237.8	0.589	0.032	0.347
2009	20.3	487.8	243.9	0.604	0.042	0.447
2010	18.9	495.1	247.6	0.615	0.038	0.409
2011	15.7	503.3	251.6	0.626	0.031	0.333
2012	13.6	514.4	257.2	0.643	0.026	0.280
2013	16.1	527.4	263.7	0.660	0.030	0.321

Table 51. Percentiles of estimated parameters and derived quantities from the XDB-SRA model for China rockfish (south of 40° 10′ N lat.). OFL estimates assume projections of constant catch, equal to average catch from 2010-2012.

		Percentile				
Quantity	**Derived or Estimated**	**5%**	**25%**	**50%**	**75%**	**95%**
log q (index 1)	Derived	-10.322	-9.520	-9.110	-8.784	-8.420
log q (index 2)	Derived	-10.075	-9.284	-8.892	-8.556	-8.181
log a (index 1)	Estimated	-2.156	-1.567	-1.203	-0.856	-0.379
log a (index 2)	Estimated	-3.592	-3.007	-2.616	-2.241	-1.744
M	Estimated	0.038	0.055	0.070	0.089	0.126
F_{MSY} / M	Estimated	0.693	1.081	1.436	1.857	2.662
Delta (year: 2000)	Estimated	0.294	0.442	0.539	0.624	0.714
B_{MSY} / B_0	Estimated	0.274	0.372	0.446	0.523	0.632
F_{MSY}	Derived	0.040	0.074	0.104	0.136	0.195
E_{MSY}	Derived	0.038	0.069	0.096	0.122	0.168
MSY	Derived	25.86	31.05	33.82	36.98	46.15
B_{MSY}	Derived	213.8	284.1	361.0	482.3	832.7
Vulnerable Biomass (1916)	Derived	491.3	645.0	811.0	1086.4	1999.3
Vulnerable Biomass (2015)	Derived	327.4	432.3	546.2	733.3	1431.7
OFL 2015	Derived	29.06	42.07	52.10	64.67	101.46

Table 52. Sensitivity analyses for China rockfish (south of 40° 10′ N lat.) presented at the STAR Panel. Results are not based on the final (base) model. 'oldBase' uses productivity priors from Dick and MacCall (2010), 'Zhou' uses diffuse priors for F_{MSY}/M and B_{MSY}/B_0 (see text for details), and runs starting with 'Z-' are the 'Zhou' run fit to single indices of abundance.

Run	SB_0	SB_{2013}	SB_{2013}/SB_0	F_{2012}/F_{MSY}	OFL_{2015}	OFL_{2016}
oldBase	747.9 (382.9 - 2166.9)	463.2 (202.9 - 1818.8)	0.65 (0.45 - 0.87)	0.29 (0.1 - 0.58)	47.4 (24 - 139.4)	47.9 (24.2 - 139.8)
Zhou	463.9 (264.1 - 2050.1)	310.8 (164.8 - 1666.3)	0.69 (0.45 - 0.93)	0.27 (0.1 - 0.5)	52.5 (28.3 - 142.4)	53.4 (28.8 - 142.7)
Z-CenCalObsOnly	387.5 (240.9 - 1024)	201.8 (114.6 - 663)	0.53 (0.33 - 0.82)	0.34 (0.18 - 0.63)	41.9 (22.9 - 77.8)	43.1 (23.3 - 78.5)
Z-RecFINOnly	1166.4 (463 - 4426.6)	710.4 (230.2 - 3888.4)	0.67 (0.34 - 0.93)	0.27 (0.06 - 1.04)	52.5 (13.4 - 263.8)	52.7 (13.3 - 263.8)

7.2.1.3 Copper rockfish

7.2.1.3.1 North of 34° 27′ N lat.

Table 53. Time series from the XDB-SRA model for copper rockfish (north of 34° 27′ N lat.). Derived quantities (biomasses, depletion, and exploitation rates) are median values. Catch is total catch (landings + discard).

Year	Catch	Vulnerable Biomass	Spawning Biomass	Depletion	Exploitation Rate	Exp. Rate / Emsy
1916	4.1	3407.3	1703.7	1.000	0.001	0.014
1917	6.4	3403.2	1701.6	0.999	0.002	0.022
1918	7.8	3397.1	1698.5	0.997	0.002	0.027
1919	5.1	3390.1	1695.0	0.995	0.001	0.018
1920	5.2	3386.3	1693.1	0.994	0.002	0.018
1921	4.5	3382.7	1691.4	0.993	0.001	0.016
1922	3.8	3380.7	1690.3	0.992	0.001	0.013
1923	4.0	3379.7	1689.8	0.992	0.001	0.014
1924	2.7	3378.3	1689.2	0.991	0.001	0.009
1925	4.0	3378.4	1689.2	0.992	0.001	0.014
1926	5.1	3377.9	1688.9	0.991	0.002	0.018
1927	3.8	3376.1	1688.0	0.991	0.001	0.013
1928	5.4	3375.3	1687.7	0.991	0.002	0.019
1929	6.4	3373.4	1686.7	0.990	0.002	0.022
1930	9.3	3371.1	1685.6	0.989	0.003	0.032
1931	11.4	3366.1	1683.0	0.988	0.003	0.040
1932	11.9	3359.0	1679.5	0.986	0.004	0.042
1933	12.3	3352.9	1676.4	0.984	0.004	0.043
1934	12.2	3346.1	1673.0	0.982	0.004	0.043
1935	15.6	3339.9	1670.0	0.980	0.005	0.055
1936	16.4	3330.9	1665.5	0.977	0.005	0.058
1937	19.2	3321.4	1660.7	0.975	0.006	0.068
1938	18.4	3309.9	1655.0	0.971	0.006	0.065
1939	16.5	3301.1	1650.5	0.969	0.005	0.059
1940	21.3	3295.5	1647.8	0.967	0.006	0.076
1941	20.4	3285.5	1642.8	0.964	0.006	0.073
1942	10.1	3277.6	1638.8	0.962	0.003	0.036
1943	11.0	3280.4	1640.2	0.963	0.003	0.040
1944	15.6	3281.8	1640.9	0.964	0.005	0.056
1945	30.8	3277.5	1638.7	0.963	0.009	0.111
1946	39.4	3261.1	1630.6	0.957	0.012	0.142
1947	18.8	3237.3	1618.6	0.950	0.006	0.068
1948	32.7	3235.1	1617.6	0.950	0.010	0.118
1949	34.7	3219.1	1609.6	0.945	0.011	0.127
1950	39.6	3201.7	1600.8	0.941	0.012	0.145
1951	54.4	3181.8	1590.9	0.935	0.017	0.201
1952	45.6	3148.4	1574.2	0.925	0.014	0.170
1953	36.5	3125.2	1562.6	0.919	0.012	0.137
1954	47.2	3115.1	1557.6	0.916	0.015	0.178
1955	52.7	3095.5	1547.8	0.911	0.017	0.200
1956	60.4	3072.3	1536.1	0.904	0.020	0.231
1957	58.6	3043.4	1521.7	0.896	0.019	0.226
1958	99.5	3017.7	1508.8	0.889	0.033	0.387
1959	80.6	2953.7	1476.9	0.871	0.027	0.320
1960	68.7	2914.8	1457.4	0.860	0.024	0.276
1961	51.5	2891.8	1445.9	0.853	0.018	0.209
1962	64.0	2887.8	1443.9	0.852	0.022	0.259
1963	79.8	2869.3	1434.6	0.848	0.028	0.324
1964	71.2	2838.9	1419.4	0.839	0.025	0.292

Table 53 (Continued). Time series from the XDB-SRA model for copper rockfish (north of 34° 27′ N lat.). Derived quantities (biomasses, depletion, and exploitation rates) are median values. Catch is total catch (landings + discard).

Year	Catch	Vulnerable Biomass	Spawning Biomass	Depletion	Exploitation Rate	Exp. Rate / Emsy
1965	105.8	2820.4	1410.2	0.834	0.038	0.435
1966	121.9	2769.6	1384.8	0.819	0.044	0.511
1967	129.7	2705.7	1352.8	0.800	0.048	0.556
1968	137.2	2639.1	1319.6	0.781	0.052	0.603
1969	147.7	2569.7	1284.8	0.761	0.057	0.666
1970	182.4	2495.4	1247.7	0.740	0.073	0.847
1971	171.2	2392.1	1196.0	0.711	0.072	0.830
1972	217.7	2310.6	1155.3	0.687	0.094	1.093
1973	249.2	2187.8	1093.9	0.651	0.114	1.325
1974	274.2	2044.3	1022.1	0.608	0.134	1.564
1975	270.3	1888.1	944.0	0.562	0.143	1.677
1976	299.5	1745.3	872.6	0.520	0.172	2.011
1977	309.0	1577.9	788.9	0.472	0.196	2.287
1978	285.0	1419.9	709.9	0.425	0.201	2.349
1979	295.8	1293.9	646.9	0.389	0.229	2.665
1980	117.4	1162.0	581.0	0.350	0.101	1.173
1981	400.4	1214.9	607.4	0.369	0.330	3.794
1982	220.6	971.3	485.6	0.294	0.227	2.636
1983	175.6	915.4	457.7	0.278	0.192	2.219
1984	144.8	895.4	447.7	0.273	0.162	1.861
1985	160.0	899.7	449.8	0.274	0.178	2.042
1986	124.7	870.3	435.2	0.266	0.143	1.639
1987	102.1	890.0	445.0	0.272	0.115	1.308
1988	96.9	901.4	450.7	0.275	0.108	1.231
1989	108.1	911.9	455.9	0.278	0.119	1.362
1990	123.3	906.3	453.1	0.275	0.136	1.564
1991	130.1	885.2	442.6	0.269	0.147	1.688
1992	152.4	857.7	428.8	0.260	0.178	2.046
1993	149.4	811.5	405.8	0.245	0.184	2.114
1994	83.7	774.6	387.3	0.234	0.108	1.239
1995	70.6	807.4	403.7	0.244	0.087	1.003
1996	89.3	848.1	424.1	0.257	0.105	1.201
1997	91.6	866.7	433.3	0.262	0.106	1.209
1998	60.8	876.9	438.4	0.265	0.069	0.794
1999	54.6	910.6	455.3	0.274	0.060	0.686
2000	39.8	942.1	471.0	0.283	0.042	0.484
2001	35.8	989.9	494.9	0.297	0.036	0.414
2002	28.2	1044.9	522.5	0.314	0.027	0.308
2003	28.3	1103.4	551.7	0.331	0.026	0.294
2004	23.2	1159.0	579.5	0.348	0.020	0.229
2005	41.2	1217.7	608.9	0.366	0.034	0.387
2006	43.1	1257.0	628.5	0.377	0.034	0.391
2007	48.6	1297.1	648.5	0.389	0.037	0.427
2008	38.9	1335.7	667.8	0.401	0.029	0.333
2009	45.7	1386.9	693.4	0.416	0.033	0.375
2010	34.4	1433.3	716.6	0.429	0.024	0.272
2011	35.6	1491.3	745.7	0.446	0.024	0.270
2012	44.9	1547.2	773.6	0.462	0.029	0.328
2013	38.3	1589.5	794.8	0.476	0.024	0.271

Table 54. Percentiles of estimated parameters and derived quantities from the XDB-SRA model for copper rockfish (north of 34° 27′ N lat.). OFL estimates assume projections of constant catch, equal to average catch from 2010-2012.

		Percentile				
Quantity	**Derived or Estimated**	**5%**	**25%**	**50%**	**75%**	**95%**
log q (index 1)	Derived	-10.308	-9.805	-9.515	-9.243	-8.890
log q (index 2)	Derived	-10.586	-10.074	-9.775	-9.507	-9.166
log q (index 3)	Derived	-11.563	-11.118	-10.849	-10.592	-10.230
log a (index 1)	Estimated	-3.430	-2.964	-2.613	-2.282	-1.794
log a (index 2)	Estimated	-2.612	-1.981	-1.604	-1.251	-0.760
log a (index 3)	Estimated	-3.753	-2.473	-1.861	-1.320	-0.708
M	Estimated	0.050	0.070	0.089	0.113	0.159
F_{MSY} / M	Estimated	0.631	0.880	1.090	1.349	1.819
Delta (year: 2000)	Estimated	0.479	0.635	0.717	0.780	0.843
B_{MSY} / B_0	Estimated	0.231	0.325	0.402	0.489	0.606
F_{MSY}	Derived	0.054	0.079	0.099	0.121	0.164
E_{MSY}	Derived	0.051	0.073	0.090	0.108	0.142
MSY	Derived	86.6	104.5	118.2	133.1	155.5
B_{MSY}	Derived	839.5	1112.8	1334.4	1605.6	2119.9
Vulnerable Biomass (1916)	Derived	2333.0	2936.9	3407.3	3894.9	4964.6
Vulnerable Biomass (2015)	Derived	998.1	1369.7	1691.2	2142.1	3055.5
OFL 2015	Derived	80.5	117.4	150.8	195.9	277.3

Table 55. Sensitivity analyses for copper rockfish (preliminary coastwide model) presented at the STAR Panel. Results are not based on the final (base) model. 'oldBase' uses productivity priors from Dick and MacCall (2010), 'Zhou' uses diffuse priors for F_{MSY}/M and B_{MSY}/B_0 (see text for details), and runs starting with 'Z-' are the 'Zhou' run fit to single indices of abundance.

Run	SB0	SB2013	SB2013/SB0	F2012/FMSY	OFL2015	OFL2016
oldBase	2677.9 (1994.6 - 3868.9)	1150.8 (733.6 - 2184.5)	0.43 (0.31 - 0.64)	0.52 (0.31 - 0.82)	193.7 (123.4 - 319.1)	199 (126.2 - 323.7)
Zhou	2677.3 (1950.1 - 3902.7)	1202.2 (756.6 - 2253.2)	0.45 (0.3 - 0.73)	0.45 (0.25 - 0.77)	226.6 (134.3 - 388.4)	233.2 (138 - 395.7)
Z-NorCalORObsOnly	3660.1 (2256.9 - 7057.9)	881.1 (187.2 - 4958.9)	0.26 (0.06 - 0.77)	1.23 (0.21 - 6.17)	80.7 (13.8 - 485.3)	81.6 (13 - 487.5)
Z-CenCalObsOnly	2334.6 (1722.1 - 3110.2)	1374.1 (746.3 - 2292.1)	0.59 (0.32 - 0.95)	0.31 (0.17 - 0.58)	327.8 (179.8 - 533.6)	337.1 (185.8 - 535.4)
Z-SoCalObsOnly	2751.7 (1657.7 - 5519.9)	841.2 (247.2 - 3157.9)	0.32 (0.09 - 0.81)	0.68 (0.2 - 2.96)	150 (31.5 - 489.3)	155.3 (31 - 496.1)
Z-RecFINONly	5185.6 (3063.8 - 10457.7)	1975.8 (861.5 - 7046.1)	0.4 (0.23 - 0.72)	0.71 (0.17 - 1.97)	139.8 (49.3 - 606.4)	140.9 (49.1 - 606.2)

7.2.1.3.2 South of 34° 27′ N lat.

Table 56. Time series from the XDB-SRA model for copper rockfish (south of 34° 27′ N lat.). Derived quantities (biomasses, depletion, and exploitation rates) are median values. Catch is total catch (landings + discard).

Year	Catch	Vulnerable Biomass	Spawning Biomass	Depletion	Exploitation Rate	Exp. Rate / Emsy
1916	0.1	1883.8	941.9	1.000	0.000	0.001
1917	0.2	1883.6	941.8	1.000	0.000	0.001
1918	0.2	1883.5	941.7	1.000	0.000	0.001
1919	0.1	1883.3	941.6	1.000	0.000	0.001
1920	0.1	1883.2	941.6	1.000	0.000	0.001
1921	0.1	1883.1	941.6	1.000	0.000	0.001
1922	0.1	1883.1	941.5	1.000	0.000	0.001
1923	0.1	1883.0	941.5	1.000	0.000	0.001
1924	0.2	1883.0	941.5	1.000	0.000	0.001
1925	0.2	1882.9	941.5	1.000	0.000	0.001
1926	0.3	1882.8	941.4	1.000	0.000	0.001
1927	0.2	1882.7	941.4	1.000	0.000	0.001
1928	0.2	1882.7	941.3	0.999	0.000	0.001
1929	0.2	1882.7	941.3	0.999	0.000	0.001
1930	0.3	1882.6	941.3	0.999	0.000	0.001
1931	0.3	1882.5	941.3	0.999	0.000	0.001
1932	0.3	1882.5	941.2	0.999	0.000	0.002
1933	0.2	1882.3	941.2	0.999	0.000	0.001
1934	0.3	1882.3	941.2	0.999	0.000	0.002
1935	0.6	1882.2	941.1	0.999	0.000	0.003
1936	0.4	1881.9	940.9	0.999	0.000	0.002
1937	1.2	1881.7	940.8	0.999	0.001	0.006
1938	0.7	1880.8	940.4	0.998	0.000	0.004
1939	0.5	1880.4	940.2	0.998	0.000	0.003
1940	0.5	1880.4	940.2	0.998	0.000	0.003
1941	0.6	1880.3	940.1	0.998	0.000	0.003
1942	0.1	1880.2	940.1	0.998	0.000	0.001
1943	0.2	1880.5	940.3	0.998	0.000	0.001
1944	0.1	1880.9	940.4	0.999	0.000	0.000
1945	0.2	1881.5	940.7	0.999	0.000	0.001
1946	0.2	1881.9	941.0	0.999	0.000	0.001
1947	0.7	1882.3	941.1	0.999	0.000	0.004
1948	1.8	1881.9	940.9	0.999	0.001	0.009
1949	2.3	1880.5	940.2	0.998	0.001	0.012
1950	3.2	1878.7	939.3	0.997	0.002	0.016
1951	5.9	1876.0	938.0	0.996	0.003	0.031
1952	4.5	1871.1	935.5	0.993	0.002	0.024
1953	4.1	1867.8	933.9	0.992	0.002	0.022
1954	8.6	1865.2	932.6	0.990	0.005	0.045
1955	16.7	1858.6	929.3	0.987	0.009	0.088
1956	18.3	1844.6	922.3	0.979	0.010	0.097
1957	10.8	1830.6	915.3	0.972	0.006	0.058
1958	10.9	1826.0	913.0	0.969	0.006	0.058
1959	5.9	1822.2	911.1	0.967	0.003	0.032
1960	6.8	1823.7	911.8	0.968	0.004	0.036
1961	9.7	1823.9	911.9	0.969	0.005	0.052
1962	6.6	1823.2	911.6	0.970	0.004	0.035
1963	7.0	1827.3	913.6	0.972	0.004	0.038
1964	11.8	1831.0	915.5	0.973	0.006	0.063

Table 56 (Continued). Time series from the XDB-SRA model for copper rockfish (south of 34° 27′ N lat.). Derived quantities (biomasses, depletion, and exploitation rates) are median values. Catch is total catch (landings + discard).

Year	Catch	Vulnerable Biomass	Spawning Biomass	Depletion	Exploitation Rate	Exp. Rate / Emsy
1965	17.4	1829.0	914.5	0.972	0.010	0.093
1966	43.8	1822.1	911.0	0.969	0.024	0.234
1967	50.7	1789.4	894.7	0.952	0.028	0.277
1968	59.3	1753.0	876.5	0.933	0.034	0.331
1969	47.0	1709.7	854.9	0.910	0.027	0.270
1970	69.6	1683.0	841.5	0.894	0.041	0.407
1971	66.8	1635.2	817.6	0.869	0.041	0.404
1972	92.2	1595.2	797.6	0.847	0.058	0.572
1973	111.5	1536.1	768.0	0.816	0.073	0.721
1974	138.2	1466.8	733.4	0.779	0.094	0.942
1975	142.2	1380.9	690.5	0.733	0.103	1.039
1976	116.9	1300.8	650.4	0.689	0.090	0.914
1977	109.1	1255.5	627.8	0.666	0.087	0.884
1978	108.1	1223.5	611.8	0.650	0.088	0.898
1979	151.8	1195.0	597.5	0.638	0.127	1.288
1980	363.9	1126.7	563.3	0.602	0.323	3.294
1981	120.4	850.5	425.3	0.454	0.142	1.497
1982	224.7	845.9	423.0	0.452	0.266	2.796
1983	117.2	733.7	366.8	0.392	0.160	1.687
1984	131.3	738.8	369.4	0.397	0.178	1.865
1985	167.2	729.1	364.6	0.393	0.229	2.391
1986	141.6	679.3	339.6	0.368	0.209	2.172
1987	16.2	634.9	317.5	0.343	0.025	0.266
1988	74.7	719.6	359.8	0.391	0.104	1.065
1989	71.6	728.2	364.1	0.393	0.098	1.013
1990	57.6	739.7	369.9	0.398	0.078	0.802
1991	50.9	761.8	380.9	0.410	0.067	0.685
1992	32.6	782.3	391.1	0.422	0.042	0.426
1993	19.9	814.8	407.4	0.438	0.024	0.250
1994	62.8	868.9	434.4	0.465	0.072	0.734
1995	51.0	872.7	436.3	0.468	0.058	0.592
1996	98.0	890.6	445.3	0.477	0.110	1.110
1997	43.9	863.9	432.0	0.461	0.051	0.514
1998	55.7	895.5	447.8	0.479	0.062	0.627
1999	62.4	915.9	457.9	0.489	0.068	0.685
2000	27.4	930.7	465.3	0.499	0.029	0.293
2001	20.6	980.7	490.4	0.527	0.021	0.208
2002	14.6	1033.5	516.7	0.556	0.014	0.138
2003	17.0	1085.7	542.9	0.585	0.016	0.153
2004	16.3	1135.3	567.6	0.612	0.014	0.140
2005	30.2	1181.6	590.8	0.636	0.026	0.247
2006	13.5	1210.3	605.2	0.651	0.011	0.107
2007	30.2	1257.2	628.6	0.677	0.024	0.230
2008	26.5	1286.8	643.4	0.693	0.021	0.196
2009	25.1	1322.6	661.3	0.712	0.019	0.180
2010	23.8	1353.8	676.9	0.731	0.018	0.165
2011	44.9	1385.1	692.5	0.750	0.032	0.303
2012	50.2	1394.7	697.4	0.758	0.036	0.335
2013	39.6	1397.1	698.6	0.762	0.028	0.264

Table 57. Percentiles of estimated parameters and derived quantities from the XDB-SRA model for copper rockfish (south of 34° 27′ N lat.). OFL estimates assume projections of constant catch, equal to average catch from 2010-2012.

		Percentile				
Quantity	**Derived or Estimated**	**5%**	**25%**	**50%**	**75%**	**95%**
log q (index 1)	Derived	-11.128	-10.453	-10.111	-9.808	-9.393
log q (index 2)	Derived	-10.431	-9.636	-9.213	-8.837	-8.365
log a (index 1)	Estimated	-2.027	-1.489	-1.125	-0.761	-0.280
log a (index 2)	Estimated	-4.596	-3.145	-2.426	-1.865	-1.237
M	Estimated	0.053	0.076	0.097	0.124	0.179
F_{MSY} / M	Estimated	0.584	0.894	1.165	1.501	2.133
Delta (year: 2000)	Estimated	0.234	0.390	0.501	0.601	0.725
B_{MSY} / B_0	Estimated	0.268	0.377	0.458	0.538	0.640
F_{MSY}	Derived	0.048	0.083	0.115	0.155	0.234
E_{MSY}	Derived	0.045	0.077	0.103	0.136	0.195
MSY	Derived	60.3	78.7	90.3	100.8	123.7
B_{MSY}	Derived	485.0	676.3	860.1	1123.9	1813.8
Vulnerable Biomass (1916)	Derived	1178.1	1522.0	1883.8	2474.8	4364.7
Vulnerable Biomass (2015)	Derived	832.2	1135.6	1420.0	1846.5	3350.2
OFL 2015	Derived	74.3	119.7	153.9	188.7	288.5

7.2.2 ExSSS model estimates

Table 58. Catchability coefficient (q) and the added variance values for each survey estimated in the MLE exSSS. X: not an applicable index. NA: not available due to unrealistic models.

		Rockfishes		Flatfishes	
Survey	Parameter	Sharpchin	Yellowtail N	English sole	Rex sole
early Triennial	q	1.35	NA	1.54	10.41
	+ var	NA	NA	0.10	0.14
late Triennial	q	0.53	NA	1.52	6.31
	+ var	NA	NA	0.10	0.07
late Triennial	q	NA	0.54	NA	NA
	+ var	NA	0.24	NA	NA
NWFSC annual	q	6.89	0.22	1.22	1.79
	+ var	NA	0.02	0.29	0.00

Table 59. Results (reported as median values with 95% credibility intervals) of 5 derived outputs (Spawning biomass in the initial year (SB_0) and in 2013 (SB_{2013}), stock depletion status (SB_{2013}/SB_0), fishing status relative to MSY (F_{2012}/F_{MSY}), and OFLs in 2015 and 2016) for SSS and exSSS models.

			Derived Outputs					
Model	Group	Species	SB_0	SB_{2013}	SB_{2013}/SB_0	F_{2012}/F_{MSY}	OFL_{2015}	OFL_{2016}
exSSS AIS	Rockfishes	Sharpchin	7887 (2437-24724)	4947 (1456-21157)	0.680 (0.31-0.91)	0.02	416 (130-1474)	404 (132-1397)
		Yellowtail (N)	82974 (19363-277492)	50043 (12184-221920)	0.667 (0.35-0.90)	0.11	7218 (2646-23903)	6949 (2679-22724)
	Flatfishes	English sole	29238 (11757-94321)	25719(10444-89100)	0.879 (0.77-0.96)	0.013	10792 (7138-32391)	7890 (4921-23317)
		Rex sole	3808 (731-15814)	2966 (602-13150)	0.800 (0.64-0.93)	0.07	5764 (3089-16500)	3956 (2479-10253)
SSS	Rockfishes	Sharpchin	6204 (2273-13363)	3774 (1587-9595)	0.64 (0.39-0.87)	0.02 (0.01-0.05)	377 (158-854)	367 (159-806)
		Yellowtail (N)	54823 (10668-148869)	26819 (5673-101254)	0.56 (0.23-0.82)	0.17 (0.07-0.56)	4429 (1737-11083)	4378 (1848-10640)
	Flatfishes	English sole	32846 (7663-109934)	29368 (6562-102956)	0.89 (0.8-0.96)	0.01 (0-0.02)	13005 (6362-37567)	9274 (4149-27476)
		Rex sole	10529 (2009-37874)	7950 (1705-32430)	0.82 (0.66-0.95)	0.07 (0.02-0.11)	5956 (3552-22694)	4682 (2896-17218)

7.2.2.1 Sharpchin rockfish

Table 60. Results of base case and sensitivity runs for sharpchin rockfish using exSSS. * indicate runs that did not converge. Colored cells indicate inclusion in the model run. Gray cells indicate indices wherein additional variance was estimated.

			Sensitivity run						
Model attributes		BC	1	2	3	4	5	5	7
Index	NWFSC								
	Triennial- early								
	Triennial- late								
Parameter treatment	M- Hoenig								
	M-Hamel								
	New h prior								
	Old h prior								
Parameter estimates	M_F	0.08	0.08	*	0.08	0.07	0.06	0.12	0.08
	M_M	0.08	0.08	*	0.08	0.08	0.07	0.13	0.08
	h	0.95	0.95	*	0.95	0.95	0.92	0.95	0.75
	ln(R0)	9.16	8.88	*	8.67	8.19	7.87	9.66	8.84
Derived outputs	SB_0	16208	12210	*	9803	6464	5957	11360	11649
	SB_{2013}	14426	10422	*	8013	4449	3208	10511	9580
	SB_{2013}/SB_0	0.89	0.85	*	0.82	0.69	0.54	0.93	0.82
	F_{2012}/F_{MSY}	0.00	0.00	*	0.00	0.01	0.02	0.00	0.01
	MSY	1004	761	*	616	386	286	1106	550
	OFL_{2015}	1235	905	*	708	390	247	1311	829
	OFL_{2016}	1181	868	*	681	379	244	1221	796

7.2.2.2 Yellowtail rockfish (North of 40° 10′ N lat.)

Table 61. Results of base case and sensitivity runs for yellowtail rockfish (North of 40° 10’ N lat.) using exSSS. Colored cells indicate inclusion in the model run. Gray cells indicate indices wherein additional variance was estimated.

Model attributes		BC	Sensitivity run 1	2	3	4	5	6	7	8	9
Index	Triennial										
	NWFSC										
	Triennial- early										
	Triennial- late										
Parameter treatment	M- Hoenig										
	M-Hamel										
	New h prior										
	Old h prior										
Parameter estimates	M_F	0.11	0.10	0.11	0.11	0.11	0.11	0.10	0.11	0.13	0.11
	M_M	0.11	0.10	0.11	0.11	0.11	0.11	0.11	0.11	0.10	0.11
	h	0.95	0.94	0.95	0.95	0.95	0.96	0.93	0.95	0.95	0.75
	ln(R0)	10.28	9.82	9.84	11.66	9.82	9.73	10.25	9.80	10.37	10.27
Derived outputs	SB_0	102112	73960	63927	395204	68112	55206	96871	64878	74942	100759
	SB_{2013}	84449	52848	45693	378844	48643	37020	76057	45706	64913	79383
	SB_{2013}/SB_0	0.83	0.71	0.71	0.96	0.71	0.67	0.79	0.70	0.87	0.79
	F_{2012}/F_{MSY}	0.03	0.06	0.05	0.01	0.06	0.06	0.05	0.06	0.03	0.07
	MSY	11172	7318	7146	44268	7220	6348	10154	7005	11775	8233
	OFL_{2015}	12281	7080	7193	56591	6900	5641	9510	6582	15153	11981
	OFL_{2016}	11647	6830	6894	52816	6650	5467	9191	6350	14128	11357

7.2.2.3 English sole

Table 62. Results of base case and sensitivity runs for English sole using exSSS. Colored cells indicate inclusion in the model run. Gray cells indicate indices wherein additional variance was estimated.

Model attributes		BC	Sensitivity run 1	2	3	4	5	6	7
Index	Triennial- early								
	Triennial- late								
	NWFSC								
	Triennial								
Parameter treatment	M- Hoenig								
	M-Hamel								
Parameter	M_F	0.26	0.22	0.27	0.22	0.20	0.21	0.28	0.32
	M_M	0.26	0.05	0.29	0.23	0.25	0.27	0.28	0.40
	h	0.80	0.86	0.89	0.74	0.82	0.88	0.85	0.83
	ln(R0)	11.62	11.08	11.51	11.40	11.50	11.21	11.62	11.91
Derived outputs	SB_0	29349	24625	24714	33666	45715	32891	25567	23263
	SB_{2013}	26152	21679	22096	17437	40943	28014	22922	21252
	SB_{2013}/SB_0	0.89	0.88	0.89	0.52	0.90	0.85	0.90	0.91
	F_{2012}/F_{MSY}	0.02	0.01	0.01	0.04	0.01	0.01	0.01	0.01
	MSY	4136	4763	4143	3590	4885	3943	4146	4259
	OFL_{2015}	12092	10767	10477	8237	14629	10384	11220	11901
	OFL_{2016}	8493	8451	7286	10943	10943	7790	7739	7726

7.2.2.4 Rex sole

Table 63. Results of base case and sensitivity runs for rex sole using exSSS. * indicate runs that did not converge. Colored cells indicate inclusion in the model run. Gray cells indicate indices wherein additional variance was estimated.

			Sensitivity run						
Model attributes		BC	1	2	3	4	5	6	7
Index	Triennial- early								
	Triennial- late								
	NWFSC								
	Triennial								
Parameter treatment	M- Hoenig								
	M-Hamel								
Parameter	M_F	0.20	0.24	0.24	0.20	*	0.24	0.27	0.31
	M_M	0.19	0.20	0.22	0.20	*	0.20	0.24	0.29
	h	0.80	0.90	0.84	0.79	*	0.89	0.91	0.84
	ln(R0)	9.97	9.75	10.20	9.91	*	9.75	10.11	10.28
Derived outputs	SB_0	8162	4196	6403	7364	*	4116	4474	3768
	SB_{2013}	6474	2978	5233	4348	*	2915	3543	2790
	SB_{2013}/SB_0	0.79	0.71	0.82	0.59	*	0.71	0.79	0.74
	F_{2012}/F_{MSY}	0.07	0.09	0.07	0.12	*	0.09	0.07	0.10
	MSY	1956	1581	2107	1699	*	1578	1934	1656
	OFL_{2015}	5609	3262	5056	3600	*	3304	3969	3505
	OFL_{2016}	4259	2614	3949	3017	*	2643	3081	2717

7.2.2.5 Stripetail rockfish

Table 64. XDB-SRA results from a profile over credible values of log(q) for fishery-independent survey indices in the model. Depletion (B_{2013}/B_0) and F/F_{MSY} estimates include median (50%) and 90% interval estimates. MSY and OFL (2015) estimates are median values of the posterior distributions.

	B2013/B0			F/Fmsy			MSY	OFL15
lnq	5%	50%	95%	5%	50%	95%	50%	50%
-1	0.951	0.978	0.999	0.002	0.005	0.014	643	2341
-0.5	0.900	0.965	0.994	0.002	0.006	0.016	445	1590
0	0.872	0.942	0.998	0.003	0.009	0.023	247	845
0.5	0.810	0.909	0.998	0.004	0.011	0.033	162	540
1	0.754	0.894	0.992	0.005	0.014	0.037	132	393
1.5	0.602	0.775	0.991	0.009	0.025	0.073	68	202

7.2.3 Decision tables

Table 65. Decision table for brown rockfish (coastwide), as presented during the STAR panel. Alternative catch streams are median ABC catch projections (mt) with 40-10 adjustment based on quartiles of depletion in 2013. SSB is median female spawning stock biomass. "Depl" is median depletion, and "Overfished" is the percentage of trajectories below $0.25B_0$. See the Executive Summary (Table ES2) for final base case model results.

			STATE OF NATURE: DEPLETION IN 2013								
			Lower Quartile			Interquartile Range			Upper Quartile		
	Year	Catch	SSB	Depl	Overfished	SSB	Depl	Overfished	SSB	Depl	Overfished
	2013	101.5	480	0.29	23%	740	0.42	0%	1193	0.63	0%
	2014	101.5	493	0.30	19%	758	0.43	0%	1212	0.64	0%
	2015	101.5	506	0.30	17%	774	0.45	0%	1232	0.65	0%
	2016	101.5	521	0.31	13%	789	0.46	0%	1249	0.67	0%
Mgmt. Action: Recent Catch	2017	101.5	534	0.32	9%	807	0.47	0%	1264	0.68	0%
	2018	101.5	547	0.32	8%	824	0.48	0%	1280	0.69	0%
	2019	101.5	561	0.33	6%	842	0.49	0%	1295	0.70	0%
	2020	101.5	576	0.34	5%	861	0.50	0%	1309	0.71	0%
	2021	101.5	590	0.34	4%	877	0.51	0%	1323	0.72	0%
	2022	101.5	605	0.35	3%	894	0.52	0%	1340	0.73	0%
	2023	101.5	620	0.36	3%	912	0.53	0%	1353	0.74	0%
	2024	101.5	634	0.36	3%	927	0.53	0%	1366	0.74	0%
	Year	Catch	SSB	Depl	Overfished	SSB	Depl	Overfished	SSB	Depl	Overfished
	2013	101.5	480	0.29	23%	740	0.42	0%	1193	0.63	0%
	2014	101.5	493	0.30	19%	758	0.43	0%	1212	0.64	0%
	2015	103	506	0.30	17%	774	0.45	0%	1232	0.65	0%
	2016	107	520	0.31	15%	788	0.45	0%	1249	0.67	0%
	2017	111	531	0.32	13%	803	0.46	0%	1260	0.68	0%
Mgmt. Action: Low ABC	2018	114	539	0.32	12%	816	0.47	0%	1272	0.69	0%
	2019	117	548	0.32	11%	829	0.48	0%	1282	0.70	0%
	2020	119	557	0.33	11%	841	0.49	0%	1290	0.70	0%
	2021	121	566	0.33	10%	851	0.49	0%	1297	0.71	0%
	2022	123	572	0.33	11%	860	0.50	0%	1305	0.71	0%
	2023	125	579	0.33	11%	870	0.50	0%	1312	0.72	0%
	2024	126	586	0.34	11%	878	0.51	0%	1316	0.72	0%
	Year	Catch	SSB	Depl	Overfished	SSB	Depl	Overfished	SSB	Depl	Overfished
	2013	101.5	480	0.29	23%	740	0.42	0%	1193	0.63	0%
	2014	101.5	493	0.30	19%	758	0.43	0%	1212	0.64	0%
	2015	154	506	0.30	17%	774	0.45	0%	1232	0.65	0%
	2016	153	494	0.29	21%	762	0.44	0%	1223	0.65	0%
Mgmt. Action: Median ABC	2017	152	485	0.29	25%	757	0.44	0%	1215	0.65	0%
	2018	153	480	0.29	27%	756	0.44	0%	1212	0.65	0%
	2019	154	476	0.28	28%	757	0.44	0%	1208	0.66	0%
	2020	154	471	0.28	31%	756	0.44	0%	1204	0.66	0%
	2021	155	466	0.28	33%	754	0.44	0%	1201	0.66	0%
	2022	155	461	0.27	36%	754	0.44	0%	1203	0.66	0%
	2023	155	459	0.27	38%	751	0.44	0%	1201	0.66	0%
	2024	154	454	0.26	41%	750	0.44	0%	1198	0.66	0%
	Year	Catch	SSB	Depl	Overfished	SSB	Depl	Overfished	SSB	Depl	Overfished
	2013	101.5	480	0.29	23%	740	0.42	0%	1193	0.63	0%
	2014	101.5	493	0.30	19%	758	0.43	0%	1212	0.64	0%
	2015	222	506	0.30	17%	774	0.45	0%	1232	0.65	0%
	2016	214	460	0.27	33%	728	0.42	0%	1189	0.63	0%
	2017	209	425	0.25	47%	697	0.40	0%	1154	0.62	0%
Mgmt. Action: High ABC	2018	205	399	0.24	59%	675	0.39	0%	1130	0.61	0%
	2019	202	380	0.23	67%	661	0.38	0%	1110	0.60	0%
	2020	200	360	0.22	78%	643	0.37	0%	1092	0.59	0%
	2021	198	336	0.20	89%	626	0.36	1%	1074	0.59	0%
	2022	196	314	0.19	96%	610	0.35	3%	1059	0.58	0%
	2023	194	294	0.18	99%	594	0.34	7%	1049	0.58	0%
	2024	193	273	0.16	99%	579	0.33	12%	1036	0.57	0%

Table 66. Decision table for China rockfish (north of 40° 10′ N lat.), as presented during the STAR panel. Alternative catch streams are median ABC catch projections (mt) with 40-10 adjustment based on quartiles of depletion in 2013. SSB is median female spawning stock biomass, “Depl” is median depletion, and “Overfished” is the percentage of trajectories below $0.25B_0$. See the Executive Summary (Table ES3) for final base case model results.

			STATE OF NATURE: DEPLETION IN 2013								
			Lower Quartile			Interquartile Range			Upper Quartile		
	Year	Catch	SSB	Depl	Overfished	SSB	Depl	Overfished	SSB	Depl	Overfished
Mgmt. Action: Recent Catch	2013	15.1	46	0.22	70%	91	0.39	0%	184	0.59	0%
	2014	15.1	42	0.21	83%	89	0.38	0%	183	0.59	0%
	2015	15.1	39	0.19	95%	87	0.37	0%	182	0.59	0%
	2016	15.1	36	0.17	99%	84	0.36	3%	181	0.58	0%
	2017	15.1	33	0.16	100%	82	0.35	9%	179	0.58	0%
	2018	15.1	29	0.14	100%	79	0.34	13%	178	0.58	0%
	2019	15.1	26	0.12	100%	77	0.33	18%	176	0.58	0%
	2020	15.1	22	0.10	100%	75	0.32	24%	175	0.58	0%
	2021	15.1	18	0.08	100%	72	0.31	29%	174	0.58	0%
	2022	15.1	14	0.06	100%	70	0.30	33%	172	0.57	0%
	2023	15.1	10	0.04	100%	67	0.29	37%	172	0.57	0%
	2024	15.1	5	0.02	100%	65	0.28	41%	171	0.57	0%
	Year	Catch	SSB	Depl	Overfished	SSB	Depl	Overfished	SSB	Depl	Overfished
Mgmt. Action: Low ABC	2013	15.1	46	0.2	72%	91	0.4	0%	184	0.59	0%
	2014	15.1	42	0.21	85%	89	0.38	0%	183	0.59	0%
	2015	1.9	39	0.19	97%	87	0.37	0%	182	0.59	0%
	2016	2.3	42	0.21	83%	91	0.38	0%	188	0.61	0%
	2017	2.5	45	0.22	73%	95	0.40	0%	191	0.63	0%
	2018	2.8	48	0.22	67%	98	0.41	0%	196	0.65	0%
	2019	2.9	49	0.23	63%	101	0.42	0%	200	0.67	0%
	2020	3.0	50	0.23	60%	103	0.43	0%	203	0.68	0%
	2021	3.1	52	0.24	57%	105	0.44	0%	206	0.70	0%
	2022	3.2	53	0.24	54%	108	0.45	0%	210	0.71	0%
	2023	3.3	54	0.25	52%	110	0.46	0%	212	0.72	0%
	2024	3.4	55	0.25	50%	112	0.47	0%	215	0.73	0%
	Year	Catch	SSB	Depl	Overfished	SSB	Depl	Overfished	SSB	Depl	Overfished
Mgmt. Action: Median ABC	2013	15.1	46	0.22	72%	91	0.39	0%	184	0.59	0%
	2014	15.1	42	0.21	85%	89	0.38	0%	183	0.59	0%
	2015	7.5	39	0.19	97%	87	0.37	0%	182	0.59	0%
	2016	7.7	40	0.19	93%	88	0.37	0%	185	0.60	0%
	2017	7.9	40	0.19	91%	89	0.38	1%	186	0.61	0%
	2018	8.0	40	0.19	90%	90	0.38	1%	188	0.62	0%
	2019	8.0	39	0.18	90%	91	0.38	2%	190	0.63	0%
	2020	8.0	38	0.18	90%	91	0.38	3%	192	0.64	0%
	2021	8.1	38	0.17	90%	91	0.39	4%	193	0.65	0%
	2022	8.2	37	0.17	90%	92	0.39	5%	194	0.66	0%
	2023	8.2	36	0.16	90%	92	0.39	6%	195	0.66	0%
	2024	8.3	34	0.16	89%	92	0.39	7%	196	0.67	0%
	Year	Catch	SSB	Depl	Overfished	SSB	Depl	Overfished	SSB	Depl	Overfished
Mgmt. Action: High ABC	2013	15.1	46	0.22	72%	91	0.39	0%	184	0.59	0%
	2014	15.1	42	0.21	85%	89	0.38	0%	183	0.59	0%
	2015	18.4	39	0.19	97%	87	0.37	0%	182	0.59	0%
	2016	18.1	34	0.17	100%	83	0.35	7%	180	0.58	0%
	2017	17.9	30	0.14	100%	79	0.33	15%	176	0.57	0%
	2018	17.8	25	0.12	100%	75	0.32	23%	174	0.56	0%
	2019	17.6	21	0.10	100%	72	0.30	30%	171	0.56	0%
	2020	17.5	16	0.07	100%	68	0.29	36%	169	0.55	0%
	2021	17.4	11	0.05	100%	65	0.28	41%	167	0.55	0%
	2022	17.2	6	0.03	100%	62	0.26	46%	165	0.54	0%
	2023	17.1	tr	tr	100%	58	0.25	51%	163	0.54	0%
	2024	17.0	tr	tr	98%	55	0.23	55%	161	0.53	0%

Table 67. Decision table for China rockfish (south of 40° 10′ N lat.), as presented during the STAR panel. Alternative catch streams are median ABC catch projections (mt) with 40-10 adjustment based on quartiles of depletion in 2013. SSB is median female spawning stock biomass. “Depl” is median depletion. See the Executive Summary (Table ES4) for final base case model results.

			STATE OF NATURE: DEPLETION IN 2013					
			Lower Quartile		Interquartile Range		Upper Quartile	
	Year	Catch	SSB	Depl	SSB	Depl	SSB	Depl
Mgmt. Action: Recent Catch	2013	16	215	0.51	300	0.68	405	0.86
	2014	16	220	0.52	306	0.69	407	0.87
	2015	16	224	0.53	311	0.70	410	0.87
	2016	16	228	0.54	316	0.71	415	0.88
	2017	16	233	0.55	320	0.73	417	0.89
	2018	16	237	0.56	325	0.74	419	0.89
	2019	16	241	0.57	329	0.74	421	0.90
	2020	16	244	0.57	333	0.75	421	0.90
	2021	16	248	0.58	336	0.76	422	0.90
	2022	16	251	0.59	340	0.77	423	0.90
	2023	16	255	0.60	343	0.77	423	0.90
	2024	16	259	0.61	345	0.78	423	0.90
	Year	Catch	SSB	Depl	SSB	Depl	SSB	Depl
Mgmt. Action: Low ABC	2013	16	215	0.51	300	0.68	405	0.86
	2014	16	220	0.52	306	0.69	407	0.87
	2015	34	224	0.53	311	0.70	410	0.87
	2016	34	219	0.52	307	0.69	406	0.86
	2017	33	215	0.51	303	0.69	400	0.85
	2018	33	212	0.50	300	0.68	395	0.84
	2019	32	210	0.50	297	0.67	389	0.82
	2020	32	207	0.50	295	0.67	382	0.81
	2021	32	205	0.49	294	0.66	379	0.81
	2022	32	203	0.49	292	0.66	375	0.80
	2023	31	201	0.48	290	0.66	372	0.80
	2024	31	198	0.48	289	0.65	371	0.80
	Year	Catch	SSB	Depl	SSB	Depl	SSB	Depl
Mgmt. Action: Median ABC	2013	16	215	0.51	300	0.68	405	0.86
	2014	16	220	0.52	306	0.69	407	0.87
	2015	45	224	0.53	311	0.70	410	0.87
	2016	43	214	0.51	301	0.68	401	0.85
	2017	42	205	0.49	293	0.66	390	0.83
	2018	41	198	0.47	286	0.65	381	0.81
	2019	40	192	0.46	280	0.63	372	0.79
	2020	39	187	0.45	276	0.62	362	0.77
	2021	38	182	0.44	271	0.61	356	0.77
	2022	38	178	0.43	268	0.61	351	0.76
	2023	37	174	0.42	264	0.60	348	0.75
	2024	37	170	0.41	261	0.59	346	0.75
	Year	Catch	SSB	Depl	SSB	Depl	SSB	Depl
Mgmt. Action: High ABC	2013	16	215	0.51	300	0.68	405	0.86
	2014	16	220	0.52	306	0.69	407	0.87
	2015	58	224	0.53	311	0.70	410	0.87
	2016	55	207	0.49	295	0.67	394	0.84
	2017	52	193	0.46	281	0.64	378	0.80
	2018	49	182	0.43	269	0.61	364	0.77
	2019	47	173	0.41	261	0.59	352	0.75
	2020	46	164	0.40	253	0.57	340	0.73
	2021	45	158	0.38	247	0.56	332	0.72
	2022	44	152	0.37	241	0.54	326	0.71
	2023	43	146	0.35	236	0.53	322	0.70
	2024	43	140	0.34	231	0.52	319	0.69

Table 68. Decision table for copper rockfish (north of 34° 27′ N lat.), as presented during the STAR panel. Alternative catch streams are median ABC catch projections (mt) with 40-10 adjustment based on quartiles of depletion in 2013. SSB is median female spawning stock biomass. "Depl" is median depletion. See the Executive Summary (Table ES5) for final base case model results.

			STATE OF NATURE: DEPLETION IN 2013					
			Lower Quartile		Interquartile Range		Upper Quartile	
	Year	Catch	SSB	Depl	SSB	Depl	SSB	Depl
Mgmt. Action: Recent Catch	2013	38	556	0.32	794	0.47	1140	0.69
	2014	38	578	0.34	819	0.49	1169	0.71
	2015	38	598	0.35	845	0.50	1196	0.73
	2016	38	618	0.36	870	0.52	1226	0.75
	2017	38	637	0.37	895	0.53	1249	0.76
	2018	38	658	0.38	920	0.55	1275	0.78
	2019	38	678	0.39	947	0.56	1298	0.80
	2020	38	698	0.40	973	0.58	1318	0.81
	2021	38	717	0.42	997	0.59	1336	0.83
	2022	38	739	0.43	1022	0.61	1354	0.84
	2023	38	759	0.44	1047	0.62	1368	0.85
	2024	38	780	0.45	1071	0.64	1381	0.86
	Year	Catch	SSB	Depl	SSB	Depl	SSB	Depl
Mgmt. Action: Low ABC	2013	38	556	0.32	794	0.47	1140	0.69
	2014	38	578	0.34	819	0.49	1169	0.71
	2015	87	598	0.35	845	0.50	1196	0.73
	2016	86	593	0.35	846	0.50	1201	0.73
	2017	86	591	0.34	848	0.51	1203	0.73
	2018	87	593	0.34	854	0.51	1209	0.74
	2019	87	594	0.34	863	0.51	1213	0.75
	2020	88	597	0.35	871	0.52	1218	0.75
	2021	89	601	0.35	880	0.52	1217	0.76
	2022	90	604	0.35	887	0.53	1220	0.76
	2023	90	607	0.35	892	0.53	1220	0.76
	2024	91	610	0.35	898	0.54	1220	0.77
	Year	Catch	SSB	Depl	SSB	Depl	SSB	Depl
Mgmt. Action: Median ABC	2013	38	556	0.32	794	0.47	1140	0.69
	2014	38	578	0.34	819	0.49	1169	0.71
	2015	134	598	0.35	845	0.50	1196	0.73
	2016	131	570	0.33	822	0.49	1178	0.72
	2017	128	548	0.32	805	0.48	1159	0.71
	2018	126	531	0.31	794	0.47	1148	0.70
	2019	126	518	0.30	787	0.47	1137	0.70
	2020	125	510	0.30	781	0.47	1126	0.70
	2021	125	504	0.29	780	0.47	1119	0.69
	2022	125	496	0.29	777	0.46	1109	0.69
	2023	124	488	0.28	772	0.46	1105	0.69
	2024	123	479	0.28	767	0.46	1100	0.69
	Year	Catch	SSB	Depl	SSB	Depl	SSB	Depl
Mgmt. Action: High ABC	2013	38	556	0.32	794	0.47	1140	0.69
	2014	38	578	0.34	819	0.49	1169	0.71
	2015	198	598	0.35	845	0.50	1196	0.73
	2016	188	538	0.31	790	0.47	1146	0.69
	2017	181	490	0.29	747	0.45	1101	0.67
	2018	175	452	0.26	715	0.43	1068	0.65
	2019	171	424	0.25	689	0.41	1040	0.64
	2020	167	400	0.23	670	0.40	1016	0.63
	2021	164	384	0.22	657	0.39	994	0.62
	2022	162	365	0.21	643	0.39	979	0.61
	2023	160	343	0.20	628	0.38	966	0.60
	2024	158	321	0.19	611	0.37	956	0.60

Table 69. Decision table for copper rockfish (south of 34° 27′ N lat.). Alternative catch streams are median ABC catch projections (mt) with 40-10 adjustment based on quartiles of depletion in 2013. SSB is median female spawning stock biomass. "Depl" is median depletion. See the Executive Summary (Table ES6) for final base case model results.

			STATE OF NATURE: DEPLETION IN 2013					
			Lower Quartile		Interquartile Range		Upper Quartile	
	Year	Catch	SSB	Depl	SSB	Depl	SSB	Depl
Mgmt. Action: Recent Catch	2013	40	655	0.61	902	0.80	966	0.94
	2014	40	661	0.62	910	0.81	965	0.94
	2015	40	670	0.63	918	0.81	963	0.94
	2016	40	677	0.64	926	0.82	952	0.93
	2017	40	685	0.64	932	0.83	943	0.92
	2018	40	694	0.65	939	0.83	932	0.92
	2019	40	704	0.66	944	0.84	926	0.92
	2020	40	713	0.66	949	0.84	924	0.91
	2021	40	720	0.67	953	0.85	922	0.91
	2022	40	732	0.67	956	0.85	923	0.91
	2023	40	738	0.68	960	0.85	924	0.91
	2024	40	745	0.68	963	0.85	924	0.91
	Year	Catch	SSB	Depl	SSB	Depl	SSB	Depl
Mgmt. Action: Low ABC	2013	40	655	0.61	902	0.80	966	0.94
	2014	40	661	0.62	910	0.81	965	0.94
	2015	100	670	0.63	918	0.81	963	0.94
	2016	96	647	0.61	896	0.80	922	0.90
	2017	94	629	0.60	876	0.78	887	0.88
	2018	92	616	0.58	860	0.76	854	0.85
	2019	91	605	0.57	847	0.75	831	0.82
	2020	89	596	0.57	836	0.74	811	0.80
	2021	88	591	0.56	826	0.73	793	0.78
	2022	87	584	0.55	817	0.72	785	0.77
	2023	86	577	0.55	809	0.71	780	0.77
	2024	85	572	0.54	803	0.71	781	0.77
	Year	Catch	SSB	Depl	SSB	Depl	SSB	Depl
Mgmt. Action: Median ABC	2013	40	655	0.61	902	0.80	966	0.94
	2014	40	661	0.62	910	0.81	965	0.94
	2015	144	670	0.63	918	0.81	962	0.94
	2016	136	625	0.59	874	0.78	900	0.88
	2017	129	590	0.56	836	0.74	847	0.84
	2018	123	563	0.54	806	0.71	800	0.79
	2019	118	541	0.51	782	0.69	767	0.76
	2020	114	523	0.50	764	0.67	737	0.73
	2021	111	510	0.49	747	0.66	717	0.71
	2022	109	499	0.48	734	0.65	706	0.69
	2023	107	487	0.47	723	0.64	700	0.69
	2024	105	473	0.45	712	0.63	699	0.69
	Year	Catch	SSB	Depl	SSB	Depl	SSB	Depl
Mgmt. Action: High ABC	2013	40	655	0.61	902	0.80	966	0.94
	2014	40	661	0.62	910	0.81	965	0.94
	2015	162	670	0.63	918	0.81	962	0.94
	2016	147	616	0.58	865	0.77	891	0.87
	2017	134	576	0.55	822	0.73	833	0.82
	2018	125	547	0.52	790	0.70	784	0.78
	2019	118	527	0.50	767	0.68	752	0.74
	2020	113	509	0.49	749	0.66	722	0.72
	2021	110	499	0.48	735	0.65	705	0.70
	2022	108	488	0.46	724	0.64	696	0.69
	2023	108	475	0.45	713	0.63	693	0.68
	2024	108	461	0.44	702	0.62	691	0.68

Table 70. Decision table for sharpchin rockfish. Alternative catch streams are median ABC catch projections (mt) with 40-10 adjustment based on quartiles of depletion in 2013. "Spawning Biomass" is median female spawning stock biomass. "Depletion" is median depletion. Estimated MSY is 320 mt/year and the long-term average total yield based on $SPR_{50\%}$ is 270 mt/year.

			State of nature					
			Low		Base		High	
Quantiles			0-0.25		0.25-0.75		0.75-1.0	
	Year	Catch	Spawning Biomass	Depletion	Spawning Biomass	Depletion	Spawning Biomass	Depletion
Low Catches	2015	195	3,485	51.5%	5,798	71.8%	7,904	86.3%
	2016	195	3,476	51.2%	5,791	71.6%	7,894	85.8%
	2017	194	3,469	50.9%	5,779	71.3%	7,881	85.4%
	2018	194	3,447	50.7%	5,762	71.1%	7,867	85.0%
	2019	193	3,440	50.4%	5,752	70.9%	7,852	84.8%
	2020	192	3,431	50.1%	5,743	70.6%	7,831	84.5%
	2021	191	3,426	49.9%	5,724	70.4%	7,798	84.2%
	2022	190	3,418	49.7%	5,705	70.2%	7,769	84.1%
	2023	189	3,401	49.5%	5,685	69.9%	7,744	83.8%
	2024	189	3,395	49.3%	5,667	69.8%	7,721	83.6%
Medium Catches	2015	382	3,371	51.1%	5,628	71.2%	7,561	86.0%
	2016	372	3,393	50.6%	5,531	69.5%	7,216	82.2%
	2017	363	3,394	50.1%	5,426	67.8%	6,908	78.4%
	2018	354	3,380	49.6%	5,300	66.1%	6,570	75.2%
	2019	347	3,377	49.2%	5,177	64.3%	6,313	72.5%
	2020	339	3,365	49.0%	5,091	62.7%	6,094	69.9%
	2021	334	3,363	48.6%	4,984	61.5%	5,895	67.5%
	2022	328	3,347	48.5%	4,933	60.4%	5,720	65.4%
	2023	322	3,321	48.3%	4,840	59.4%	5,561	63.8%
	2024	317	3,336	48.2%	4,770	58.5%	5,419	62.2%
High Catches	2015	750	3,343	50.6%	5,688	71.7%	7,863	86.0%
	2016	730	2,964	44.1%	5,338	66.4%	7,567	82.3%
	2017	703	2,594	38.6%	4,999	61.8%	7,310	87.7%
	2018	674	2,257	33.6%	4,643	57.2%	7,040	75.7%
	2019	650	1,953	28.9%	4,300	53.3%	6,791	73.1%
	2020	625	1,684	24.7%	4,001	49.6%	6,498	70.5%
	2021	612	1,392	20.8%	3,691	46.7%	6,215	68.6%
	2022	591	1,190	17.1%	3,479	43.6%	6,055	66.7%
	2023	575	980	13.9%	3,266	41.0%	5,935	65.0%
	2024	563	756	10.9%	3,095	38.6%	5,816	63.5%
Average Catches	2015	5	3,485	50.6%	5,664	72.0%	7,573	86.4%
	2016	5	3,602	51.9%	5,786	73.4%	7,643	87.4%
	2017	5	3,725	53.7%	5,895	74.7%	7,708	88.2%
	2018	5	3,826	54.9%	6,020	75.9%	7,768	89.0%
	2019	5	3,938	56.3%	6,121	77.0%	7,828	89.7%
	2020	5	4,042	57.7%	6,227	78.3%	7,888	90.3%
	2021	5	4,135	59.0%	6,327	79.3%	7,944	91.1%
	2022	5	4,260	60.4%	6,420	80.3%	7,998	91.6%
	2023	5	4,318	61.6%	6,510	81.2%	8,048	92.2%
	2024	5	4,418	62.6%	6,599	82.2%	8,096	92.8%

Table 71. Decision table for yellowtail rockfish (north of 40° 10′ N lat.). Alternative catch streams are median ABC catch projections (mt) with 40-10 adjustment based on quartiles of depletion in 2013. "Spawning Biomass" is median female spawning stock biomass. "Depletion" is median depletion. Estimated MSY is 5728 mt/year and the long-term average total yield based on $SPR_{50\%}$ is 4805 mt/year.

			State of nature					
			Low		Base		High	
Quantiles			0-0.25		0.25-0.75		0.75-1.0	
	Year	Catch	Spawning Biomass	Depletion	Spawning Biomass	Depletion	Spawning Biomass	Depletion
Low Catches	2015	3,936	43,502	52.8%	56,604	68.9%	62,979	83.4%
	2016	3,912	43,108	52.4%	56,063	68.3%	62,573	82.7%
	2017	3,879	42,738	52.0%	55,772	67.9%	62,187	81.9%
	2018	3,844	42,434	51.7%	55,468	67.4%	61,835	81.2%
	2019	3,818	42,206	51.3%	55,027	66.7%	61,524	80.6%
	2020	3,797	41,976	50.9%	54,624	66.4%	61,253	79.9%
	2021	3,777	41,749	50.6%	54,269	66.0%	61,019	79.6%
	2022	3,759	41,547	50.4%	53,958	65.7%	60,818	79.3%
	2023	3,744	41,393	50.1%	53,684	65.3%	60,644	79.0%
	2024	3,730	41,129	50.0%	53,444	64.9%	60,491	78.8%
Medium Catches		6,497	43,502	52.4%	54,304	69.3%	60,039	83.3%
	2016	6,312	43,252	52.1%	52,730	66.8%	55,750	87.0%
	2017	6,126	43,044	51.6%	51,060	64.6%	52,853	73.9%
	2018	5,962	42,955	51.1%	49,531	62.7%	50,294	70.5%
	2019	5,798	42,673	50.7%	48,227	61.0%	48,062	67.2%
	2020	5,638	42,597	50.4%	47,111	49.4%	46,136	64.4%
	2021	5,523	42,567	50.0%	46,260	58.2%	44,484	62.3%
	2022	5,417	42,547	49.9%	45,421	57.1%	43,067	60.5%
	2023	5,324	42,842	49.7%	44,594	56.2%	41,784	59.9%
	2024	5,251	42,899	49.4%	43,788	55.4%	40,810	57.6%
High Catches	2015	11,666	44,076	52.6%	54,174	69.4%	63,587	83.7%
	2016	11,148	39,125	46.6%	49,654	63.4%	60,602	78.9%
	2017	10,530	34,591	41.3%	45,256	58.0%	57,730	75.1%
	2018	10,032	30,672	36.4%	41,696	53.4%	55,222	71.7%
	2019	9,675	26,968	31.9%	38,467	49.6%	53,091	68.6%
	2020	9,333	23,925	28.2%	35,708	46.2%	51,319	66.1%
	2021	9,052	20,975	25.1%	33,481	43.0%	49,975	63.9%
	2022	8,830	18,205	22.3%	31,248	40.4%	48,657	62.2%
	2023	8,547	15,740	19.5%	29,253	38.2%	47,106	60.6%
	2024	8,311	13,900	17.0%	27,694	36.4%	46,200	59.3%
Average Catches	2015	1,376	45,023	52.7%	54,405	69.6%	61,190	83.7%
	2016	1,376	46,290	54.1%	55,352	70.7%	61,802	84.4%
	2017	1,376	47,532	55.4%	56,136	72.0%	62,370	84.9%
	2018	1,376	48,447	56.5%	56,980	72.9%	62,899	85.5%
	2019	1,376	49,334	57.7%	57,758	73.7%	63,390	86.1%
	2020	1,376	50,528	59.0%	58,506	74.6%	63,845	86.5%
	2021	1,376	51,821	59.9%	59,109	75.5%	64,267	86.9%
	2022	1,376	52,752	61.0%	59,675	76.2%	64,658	87.3%
	2023	1,376	53,532	62.1%	60,139	77.0%	65,020	87.6%
	2024	1,376	54,297	63.1%	60,643	77.7%	65,355	87.9%

Table 72. Decision table for English sole. Alternative catch streams are median ABC catch projections (mt) with 40-10 adjustment based on quartiles of depletion in 2013. "Spawning Biomass" is median female spawning stock biomass. "Depletion" is median depletion. Estimated MSY is 4072 mt/year and the long-term average total yield based on $SPR_{25\%}$ is 3875 mt/year.

			State of nature					
			Low		Base		High	
Quantiles			0-0.25		0.25-0.75		0.75-1.0	
	Year	Catch	Spawning Biomass	Depletion	Spawning Biomass	Depletion	Spawning Biomass	Depletion
Low Catches	2015	8,909	33,061	86.2%	24,798	90.7%	24,306	94.0%
	2016	7,247	26,491	67.9%	18,414	67.2%	18,274	71.1%
	2017	6,146	21,871	56.6%	14,277	52.0%	14,593	56.8%
	2018	5,379	18,728	48.7%	11,709	42.6%	12,608	48.6%
	2019	4,858	16,631	43.3%	10,061	37.1%	11,880	44.2%
	2020	4,529	15,286	39.7%	9,293	34.0%	11,515	43.0%
	2021	4,305	14,401	97.2%	8,908	32.3%	11,386	42.1%
	2022	4,151	13,766	35.5%	8,606	31.3%	11,128	41.4%
	2023	4,018	13,279	34.3%	8,424	30.7%	11,077	41.8%
	2024	3,939	12,947	33.4%	8,319	30.2%	10,982	42.0%
Medium Catches	2015	9,452	33,131	86.2%	24,735	90.7%	24,844	94.1%
	2016	4,098	26,338	67.7%	18,131	65.7%	16,751	63.2%
	2017	5,733	61,662	55.5%	14,115	50.8%	12,720	47.3%
	2018	4,972	18,441	47.3%	11,791	42.4%	10,602	39.6%
	2019	4,574	16,343	42.0%	10,538	37.9%	9,587	36.0%
	2020	4,332	14,991	38.6%	9,810	65.4%	9,065	34.3%
	2021	4,184	41,092	36.4%	9,401	34.0%	8,727	33.2%
	2022	4,073	13,465	34.8%	9,096	33.1%	8,490	32.6%
	2023	3,992	13,008	33.7%	8,916	32.4%	8,428	32.1%
	2024	3,922	12,662	33.0%	8,768	31.9%	8,340	31.7%
High Catches	2015	11,901	32,854	86.3%	25,220	90.6%	25,473	94.1%
	2016	2,368	23,791	61.8%	16,600	59.1%	17,158	63.6%
	2017	6,790	23,311	60.9%	16,346	58.2%	17,307	63.7%
	2018	5,975	19,630	51.5%	13,092	46.5%	14,308	53.7%
	2019	5,691	16,975	44.7%	10,874	38.8%	12,784	47.7%
	2020	5,446	14,926	39.1%	9,324	33.2%	11,642	43.0%
	2021	5,258	13,185	34.9%	8,098	29.1%	10,594	40.1%
	2022	5,106	12,087	31.5%	7,196	26.3%	10,178	38.2%
	2023	5,007	11,004	28.6%	6,557	24.3%	9,903	36.7%
	2024	4,960	10,260	26.4%	6,114	22.6%	9,600	36.2%
Average Catches	2015	224	33,061	85.9%	25,473	90.7%	25,687	94.0%
	2016	224	33,694	87.3%	24,996	91.8%	25,853	94.6%
	2017	224	34,117	88.5%	25,186	92.6%	25,981	95.1%
	2018	224	34,518	89.6%	25,377	93.3%	26,078	95.4%
	2019	224	34,916	90.6%	25,522	93.8%	26,153	95.7%
	2020	224	35,358	91.4%	25,635	94.3%	26,210	96.0%
	2021	224	35,746	92.1%	25,725	94.6%	26,253	96.0%
	2022	224	36,087	82.6%	25,798	94.9%	26,286	96.3%
	2023	224	36,387	93.2%	25,857	95.1%	26,312	96.4%
	2024	224	36,651	93.6%	25,904	95.3%	26,332	96.6%

Table 73. Decision table for rex sole. Alternative catch streams are median ABC catch projections (mt) with 40-10 adjustment based on quartiles of depletion in 2013. "Spawning Biomass" is median female spawning stock biomass. "Depletion" is median depletion. Estimated MSY is 1676 mt/year and the long-term average total yield based on $SPR_{25\%}$ is 1646 mt/year.

			State of nature					
			Low		Base		High	
Quantiles			0-0.25		0.25-0.75		0.75-1.0	
	Year	Catch	Spawning Biomass	Depletion	Spawning Biomass	Depletion	Spawning Biomass	Depletion
Low Catches	2015	3,085	3,772	72.9%	3,377	80.7%	4,396	89.7%
	2016	2,541	3,113	59.4%	2,837	68.8%	3,989	81.4%
	2017	2,174	2,568	50.6%	2,490	60.8%	3,742	76.1%
	2018	1,909	2,237	44.8%	2,262	55.7%	3,560	72.9%
	2019	1,753	2,102	41.1%	2,137	52.6%	3,448	71.0%
	2020	1,652	2,022	38.7%	2,031	50.6%	3,380	70.3%
	2021	1,590	1,970	36.9%	1,986	49.3%	3,339	69.7%
	2022	1,544	1,928	35.8%	1,939	48.5%	3,313	69.4%
	2023	1,510	1,887	35.2%	1,924	48.1%	3,297	69.2%
	2024	1,485	1,857	34.6%	1,917	47.9%	3,287	69.1%
Medium Catches	2015	4,395	3,788	73.4%	3,073	81.1%	4,076	89.5%
	2016	3,342	3,023	59.5%	2,382	62.0%	2,937	64.7%
	2017	2,701	2,569	50.4%	1,938	50.3%	2,313	50.7%
	2018	2,308	2,279	44.3%	1,662	43.4%	1,963	43.3%
	2019	2,067	2,086	40.5%	1,511	39.4%	1,765	39.2%
	2020	1,926	1,940	38.1%	1,421	37.1%	1,663	36.9%
	2021	1,839	1,859	36.5%	1,371	35.7%	1,602	35.7%
	2022	1,778	1,812	35.6%	1,335	34.8%	1,562	34.9%
	2023	1,738	1,784	34.9%	1,305	34.2%	1,517	34.3%
	2024	1,711	1,764	34.4%	1,283	33.8%	1,496	33.8%
High Catches	2015	7,895	3,720	73.4%	3,073	81.1%	4,093	89.5%
	2016	5,315	1,684	34.1%	1,717	44.9%	2,866	64.7%
	2017	4,116	928	20.3%	973	27.4%	2,208	51.6%
	2018	3,382	732	15.8%	731	21.0%	1,927	44.8%
	2019	1,947	685	14.0%	655	18.9%	1,726	41.2%
	2020	2,722	657	13.6%	641	18.7%	1,791	42.3%
	2021	2,547	629	13.1%	605	17.5%	1,697	40.7%
	2022	2,470	607	12.4%	571	16.4%	1,663	40.0%
	2023	2,387	594	11.9%	552	15.6%	1,612	39.5%
	2024	2,344	578	11.6%	542	15.2%	1,579	38.9%
Average Catches	2015	455	3,687	73.2%	3,158	81.0%	3,686	89.9%
	2016	455	3,761	74.4%	3,191	81.9%	3,707	90.3%
	2017	455	3,824	75.4%	3,220	82.6%	3,723	90.6%
	2018	455	3,874	76.3%	3,245	83.2%	3,737	90.9%
	2019	455	3,919	77.2%	3,266	83.7%	3,747	91.1%
	2020	455	3,959	77.9%	3,285	84.2%	3,757	91.3%
	2021	455	3,993	78.4%	3,301	84.6%	3,765	91.6%
	2022	455	4,022	78.9%	3,315	84.9%	3,771	91.7%
	2023	455	4,047	79.4%	330	85.2%	3,777	91.9%
	2024	455	4,067	79.8%	3,340	85.5%	3,782	92.0%

8 Figures

8.1 Catch and Abundance Figures

8.1.1 Distribution maps

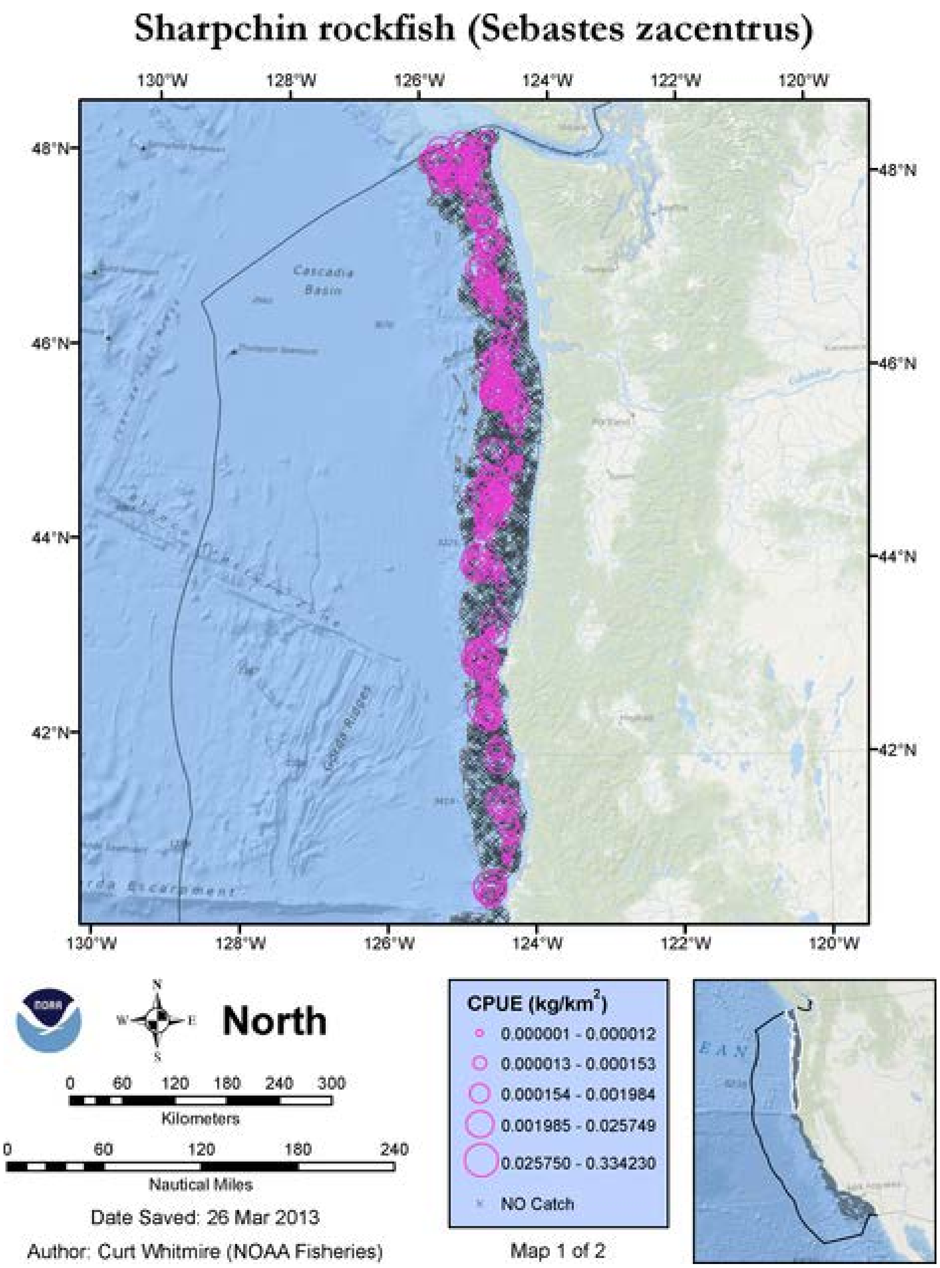

Figure 1. Occurrence and abundance of sharpchin rockfish found in the NWFSC annual survey (2003-2012) north of 40º10' N lat.

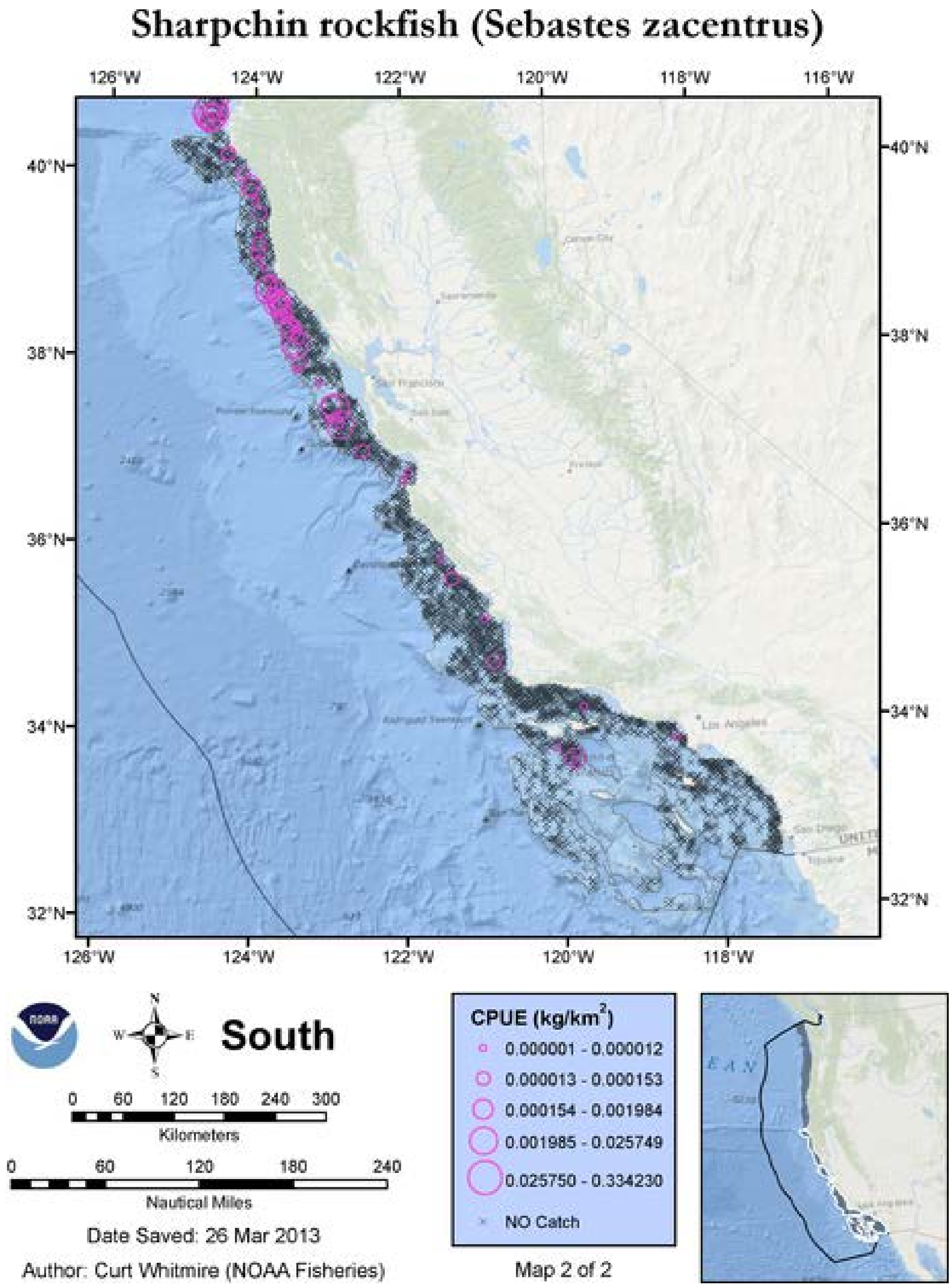

Figure 2. Occurrence and abundance of sharpchin rockfish found in the NWFSC annual survey (2003-2012) south of 40º10’ N lat.

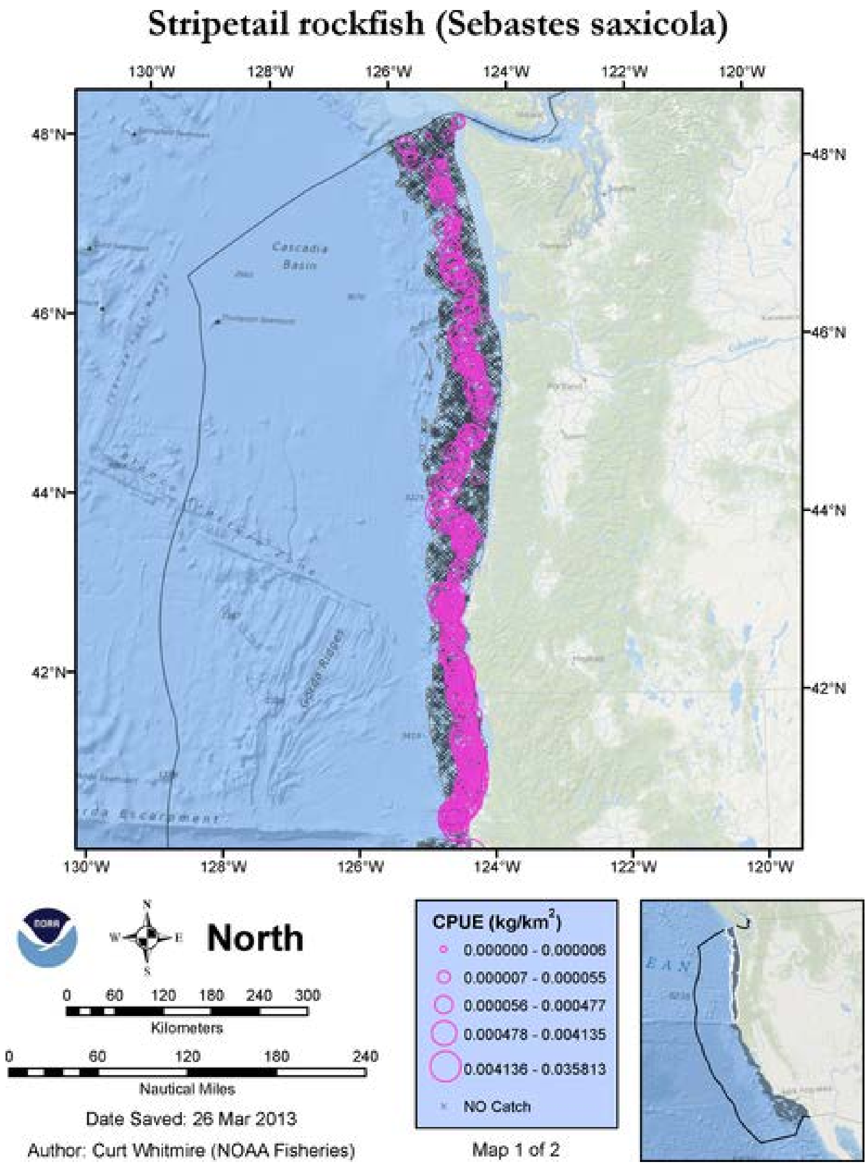

Figure 3. Occurrence and abundance of stripetail rockfish found in the NWFSC annual survey (2003-2012) north of 40º10' N lat.

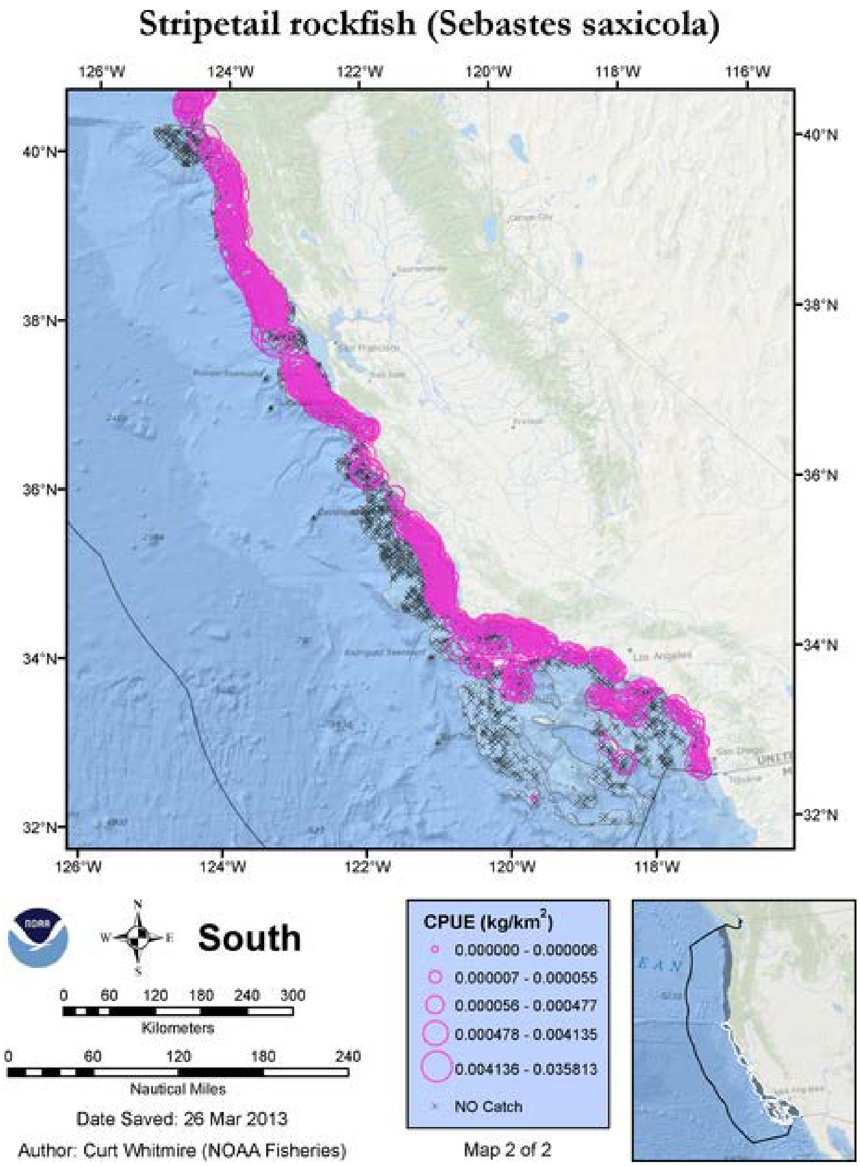

Figure 4. Occurrence and abundance of stripetail rockfish found in the NWFSC annual survey (2003-2012) south of 40º10’ N lat.

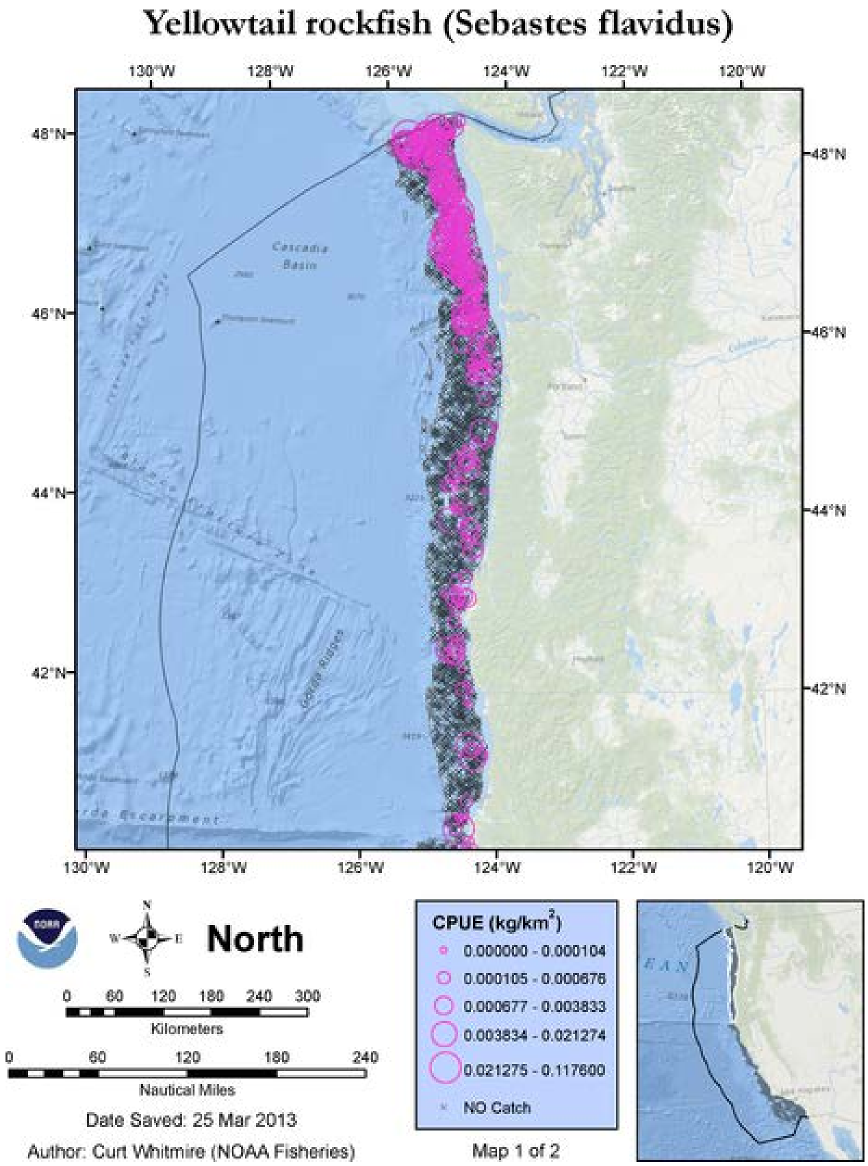

Figure 5. Occurrence and abundance of yellowtail rockfish found in the NWFSC annual survey (2003-2012) north of 40º10' N lat.

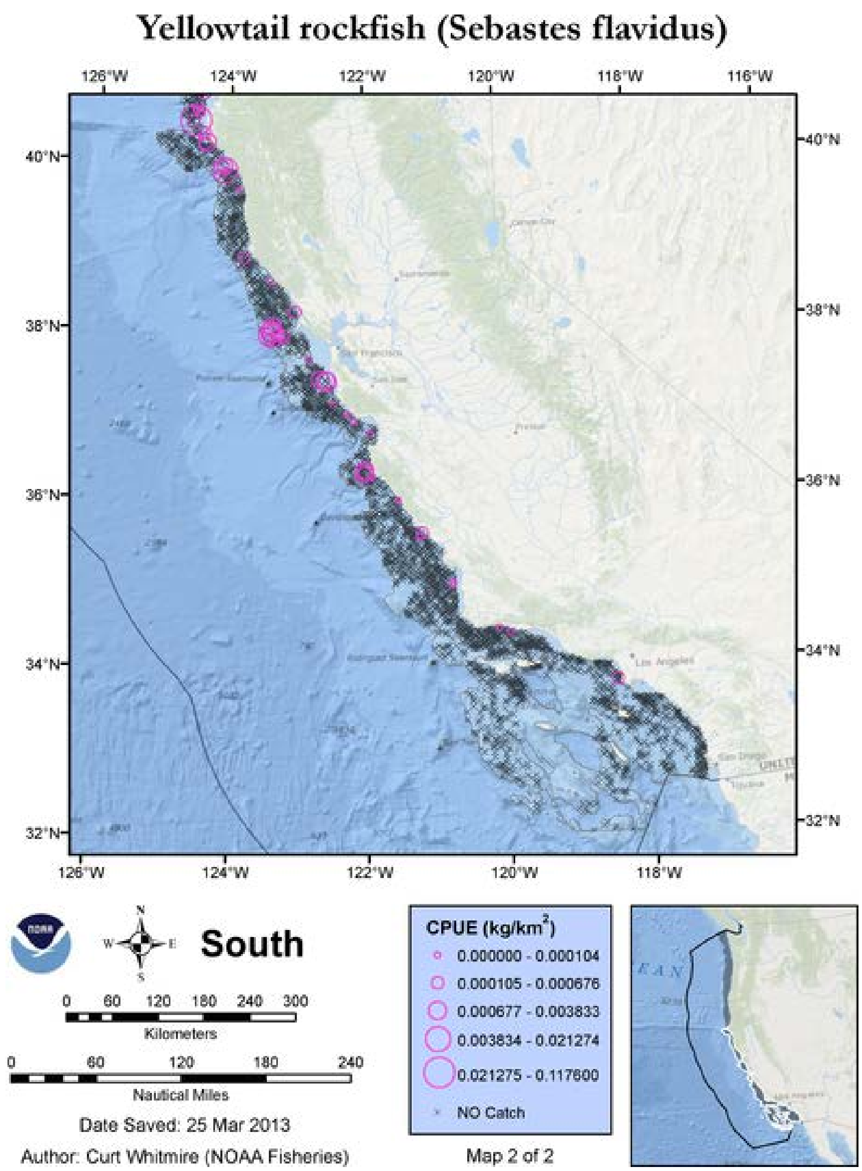

Figure 6. Occurrence and abundance of yellowtail rockfish found in the NWFSC annual survey (2003-2012) south of 40º10’ N lat.

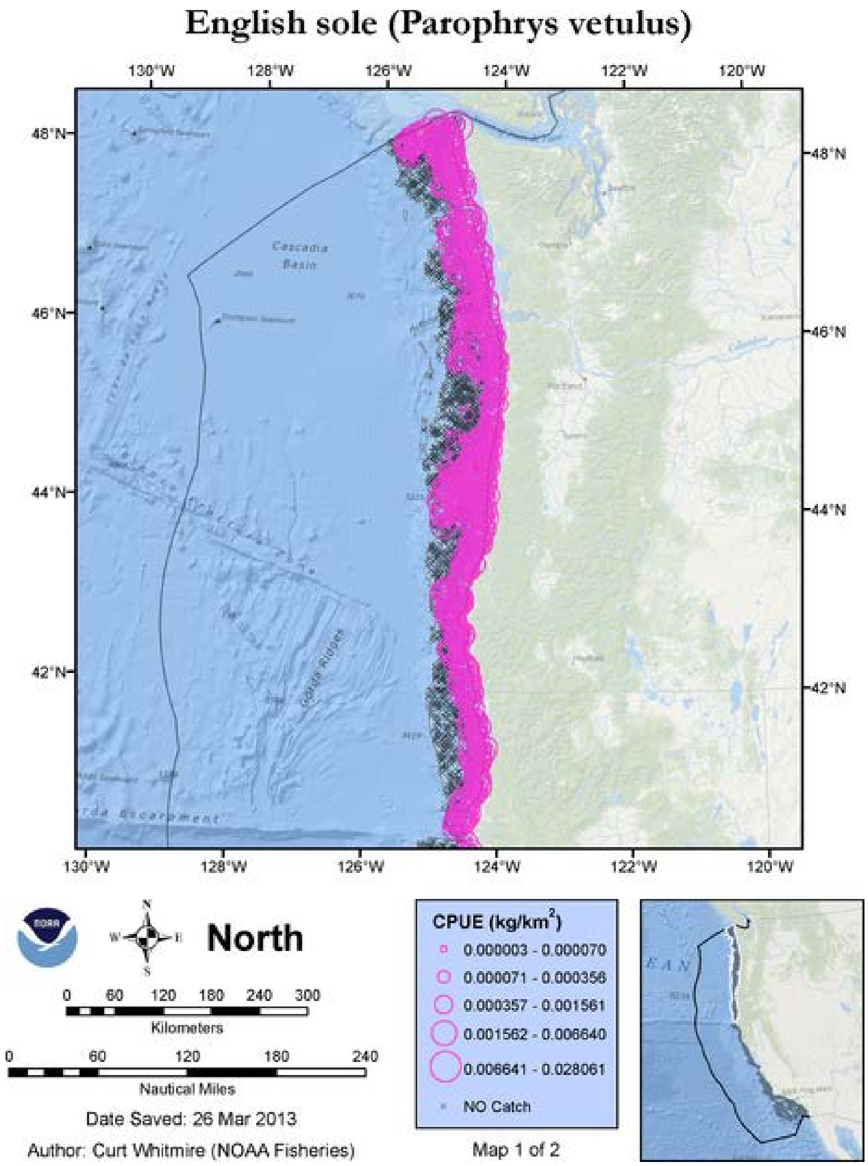

Figure 7. Occurrence and abundance of English sole found in the NWFSC annual survey (2003-2012) north of 40º10' N lat.

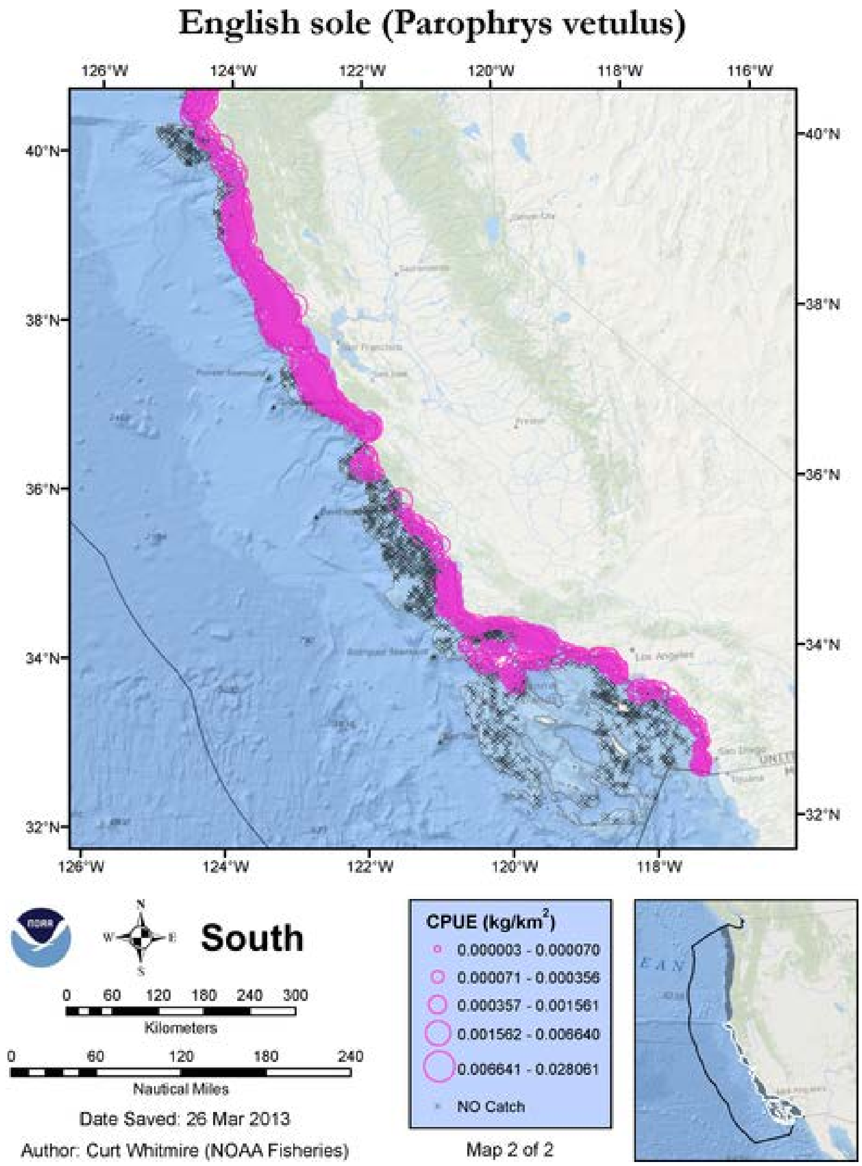

Figure 8. Occurrence and abundance of English sole found in the NWFSC annual survey (2003-2012) south of 40º10' N lat.

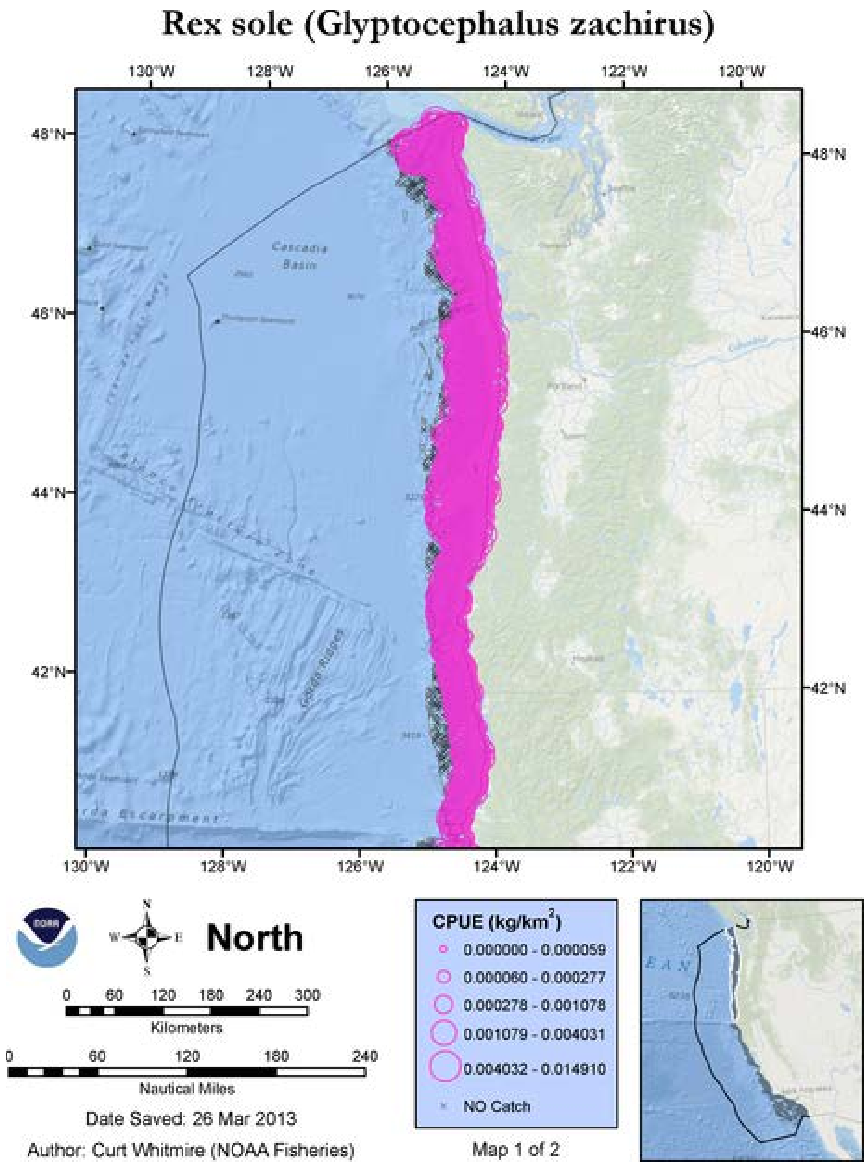

Figure 9. Occurrence and abundance of rex sole found in the NWFSC annual survey (2003-2012) north of 40º10' N lat.

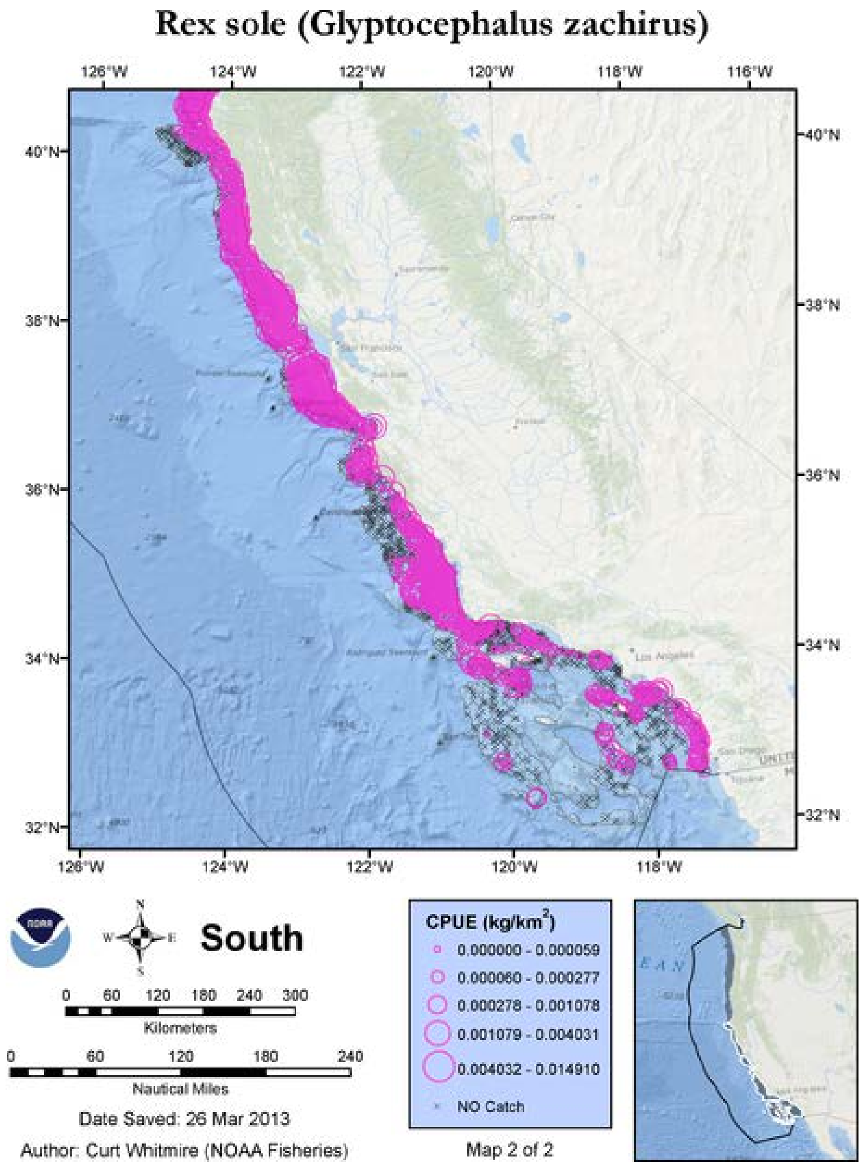

Figure 10. Occurrence and abundance of rex sole found in the NWFSC annual survey (2003-2012) south of 40º10' N lat.

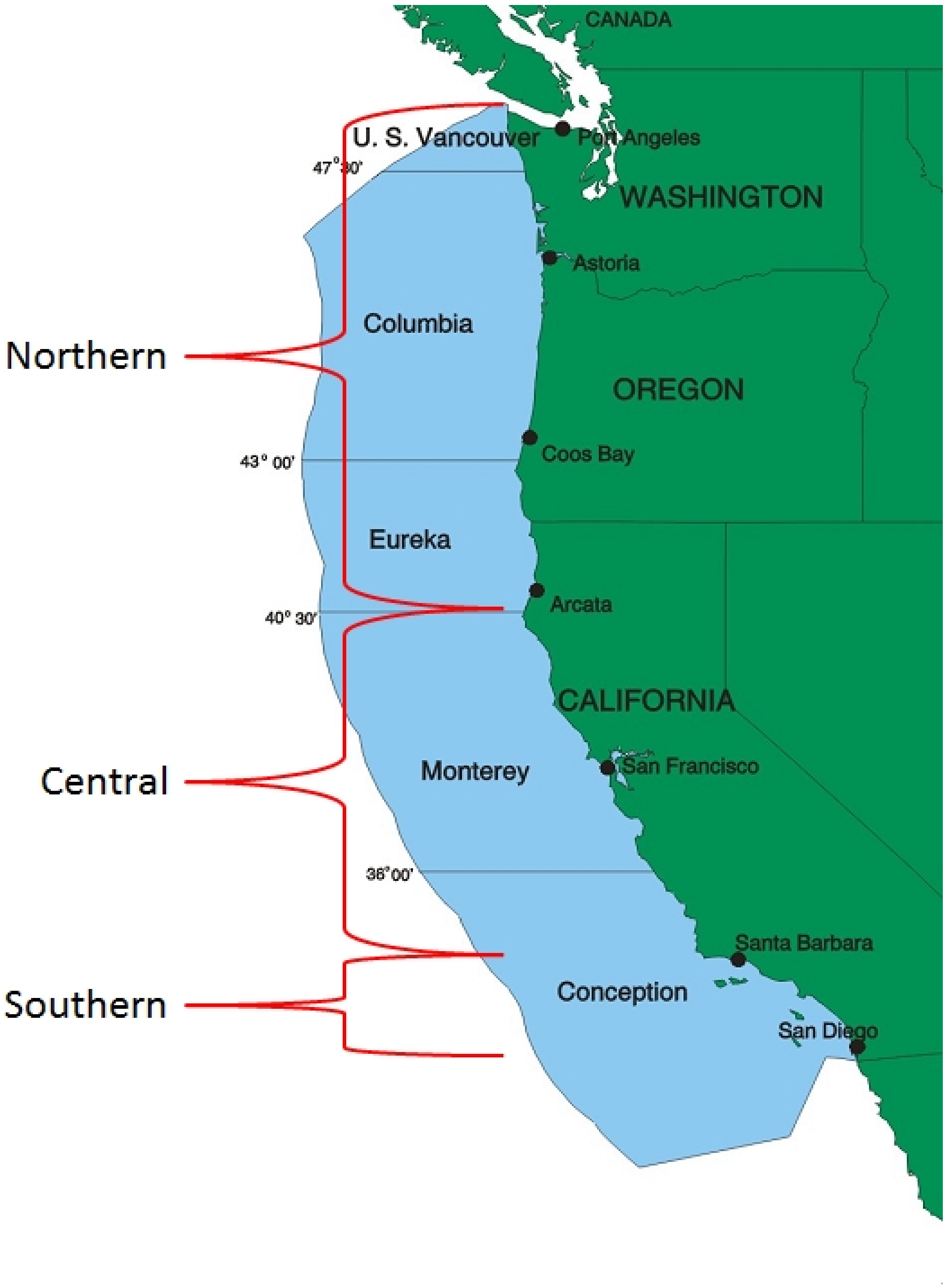

Figure 11. Northern, Central, and Southern regions (red brackets), relative to major INPFC areas (U.S. Vancouver, Columbia, Eureka, Monterey, and Conception). Adapted from Rogers (2003).

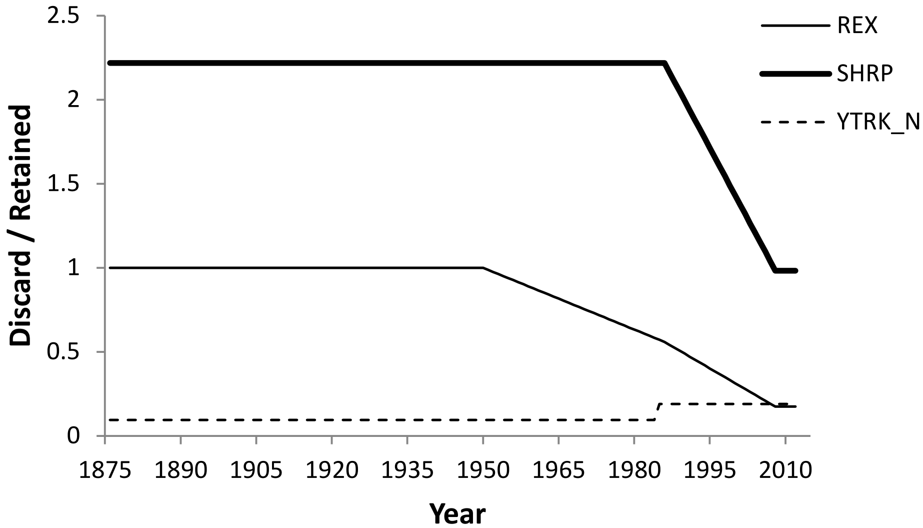

Figure 12. Assumed ratios of discarded catch to retained catch for species with time-varying rates.

8.1.2 Removal histories

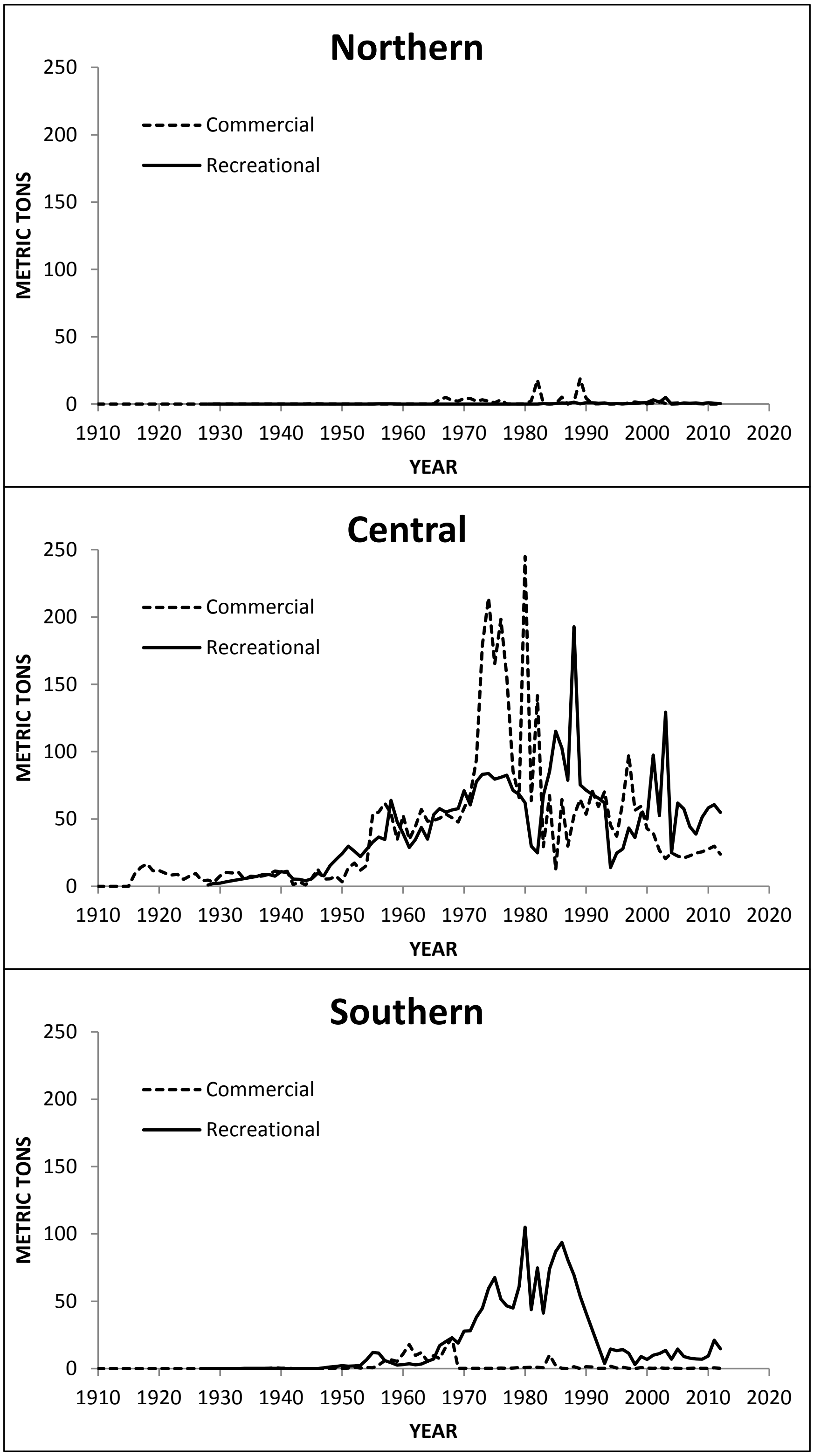

Figure 13. Brown rockfish (*Sebastes auriculatus*) catch by coastal region, year, and fishery. Coastal regions are divided at Point Conception and Cape Mendocino.

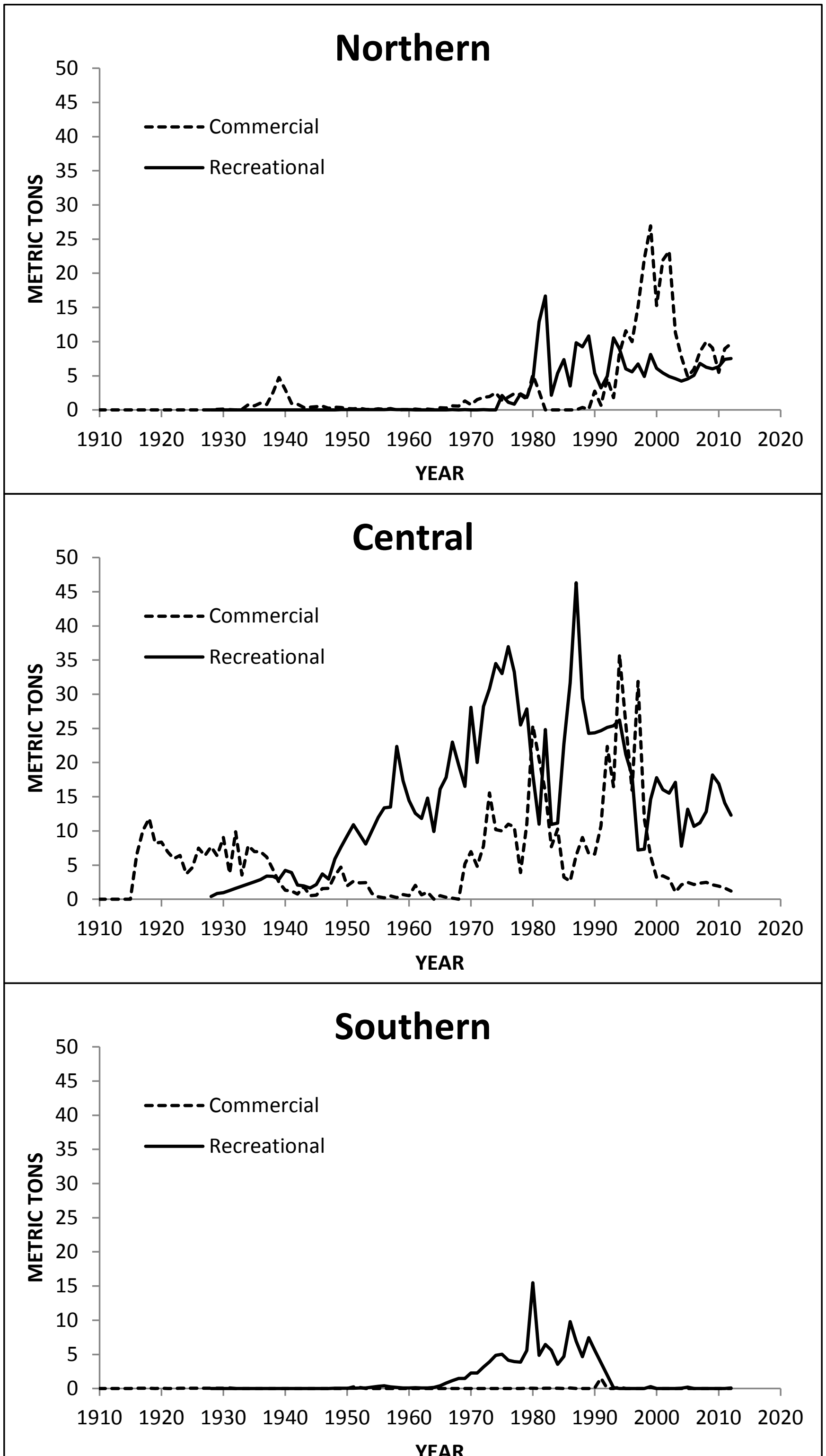

Figure 14. China rockfish (*Sebastes nebulosus*) catch by coastal region, year, and fishery. Coastal regions are divided at Point Conception and Cape Mendocino.

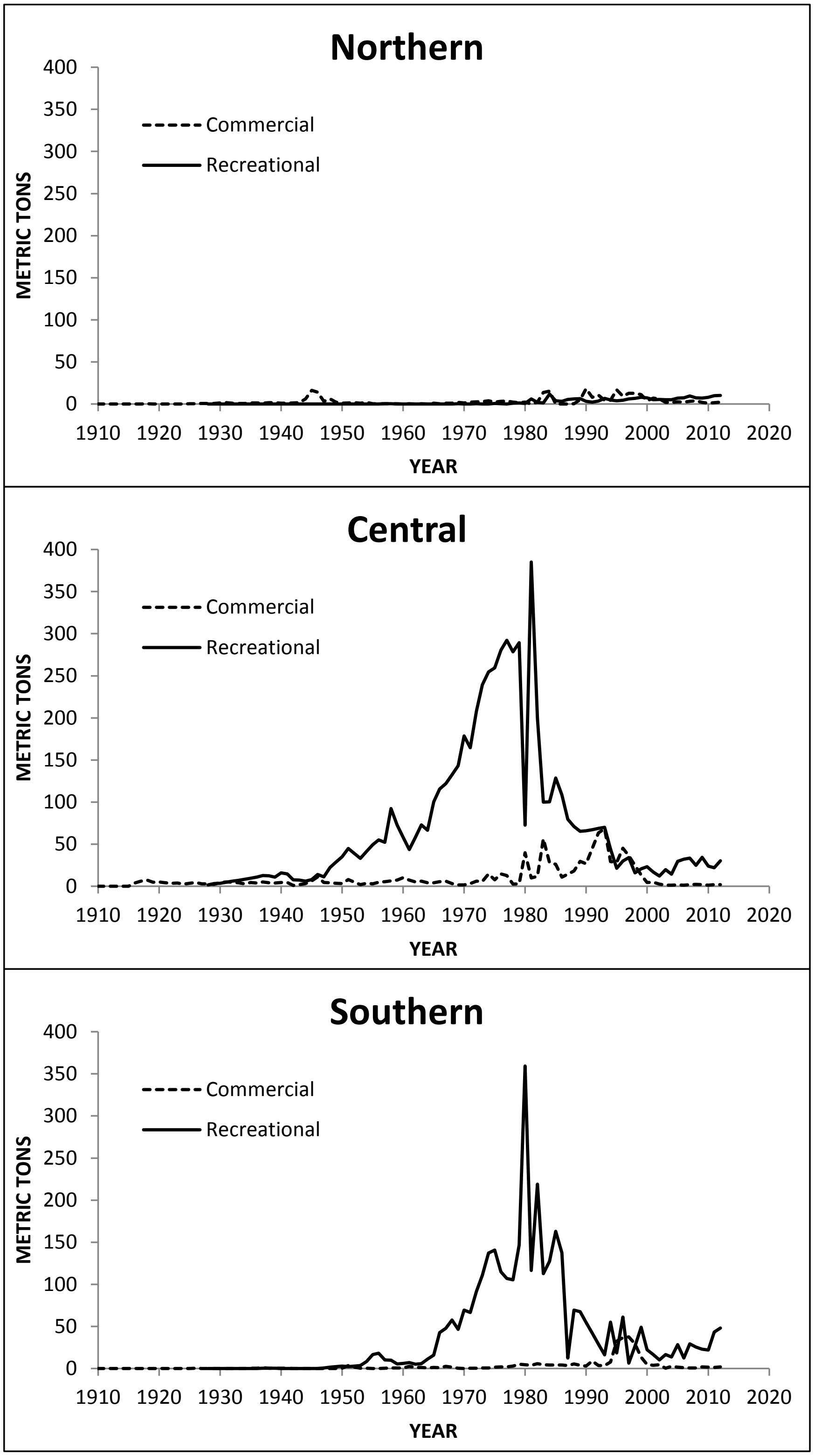

Figure 15. Copper rockfish (*Sebastes caurinus*) catch by coastal region, year, and fishery. Coastal regions are divided at Point Conception and Cape Mendocino.

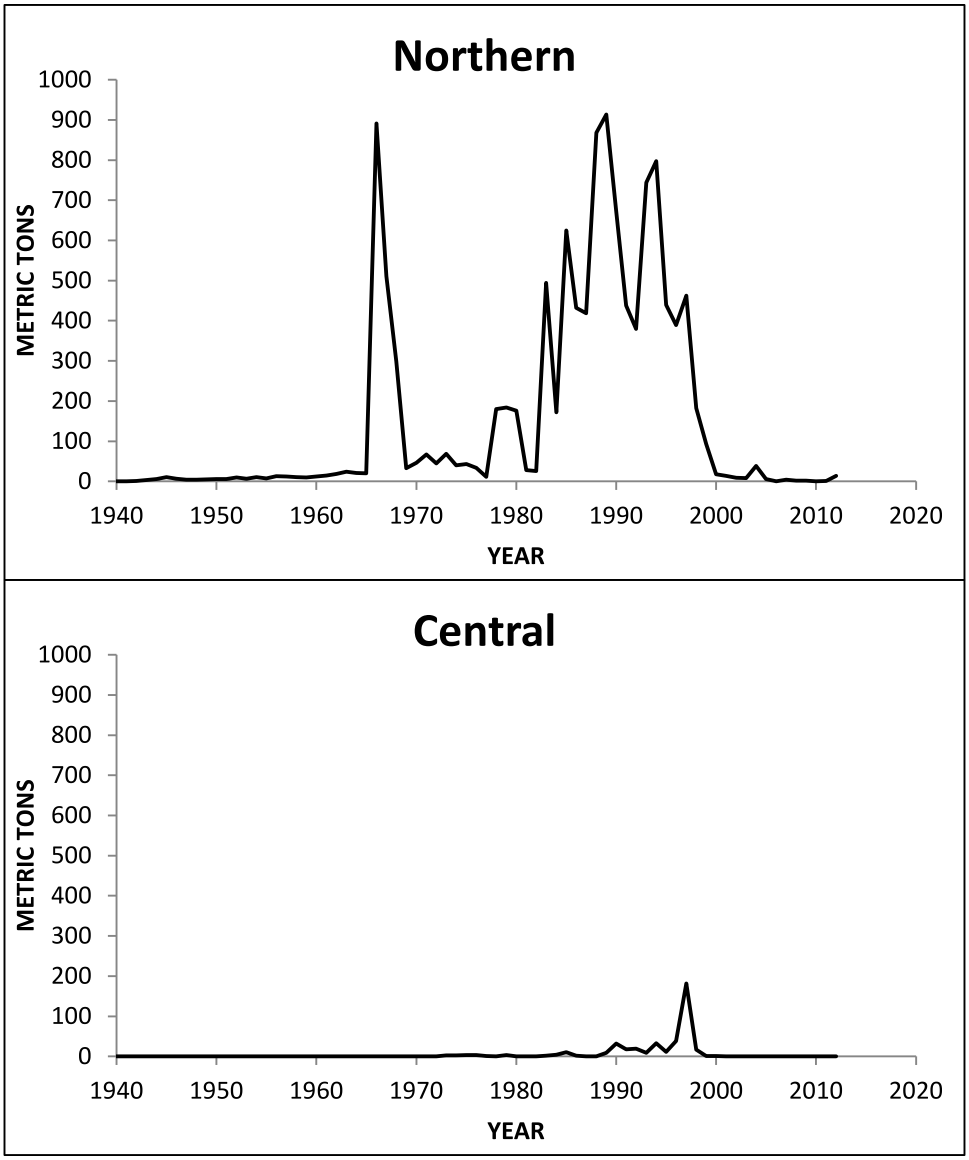

Figure 16. Sharpchin rockfish (*Sebastes zacentrus*) commercial catch by coastal region and year. Recreational catch is negligible. Coastal regions are divided at Cape Mendocino.

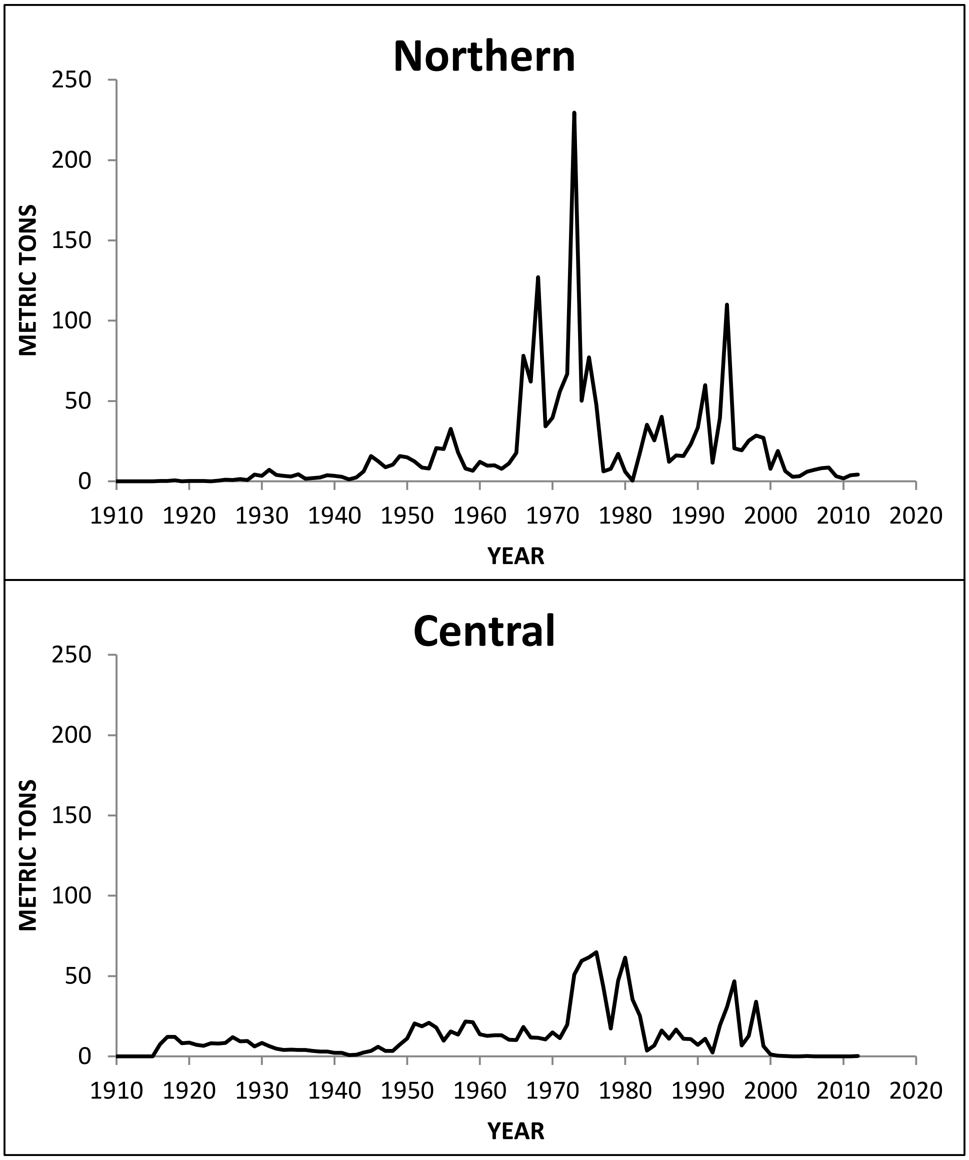

Figure 17. Stripetail rockfish (*Sebastes saxicola*) catch by coastal region, year, and fishery. Coastal regions are divided at Cape Mendocino.

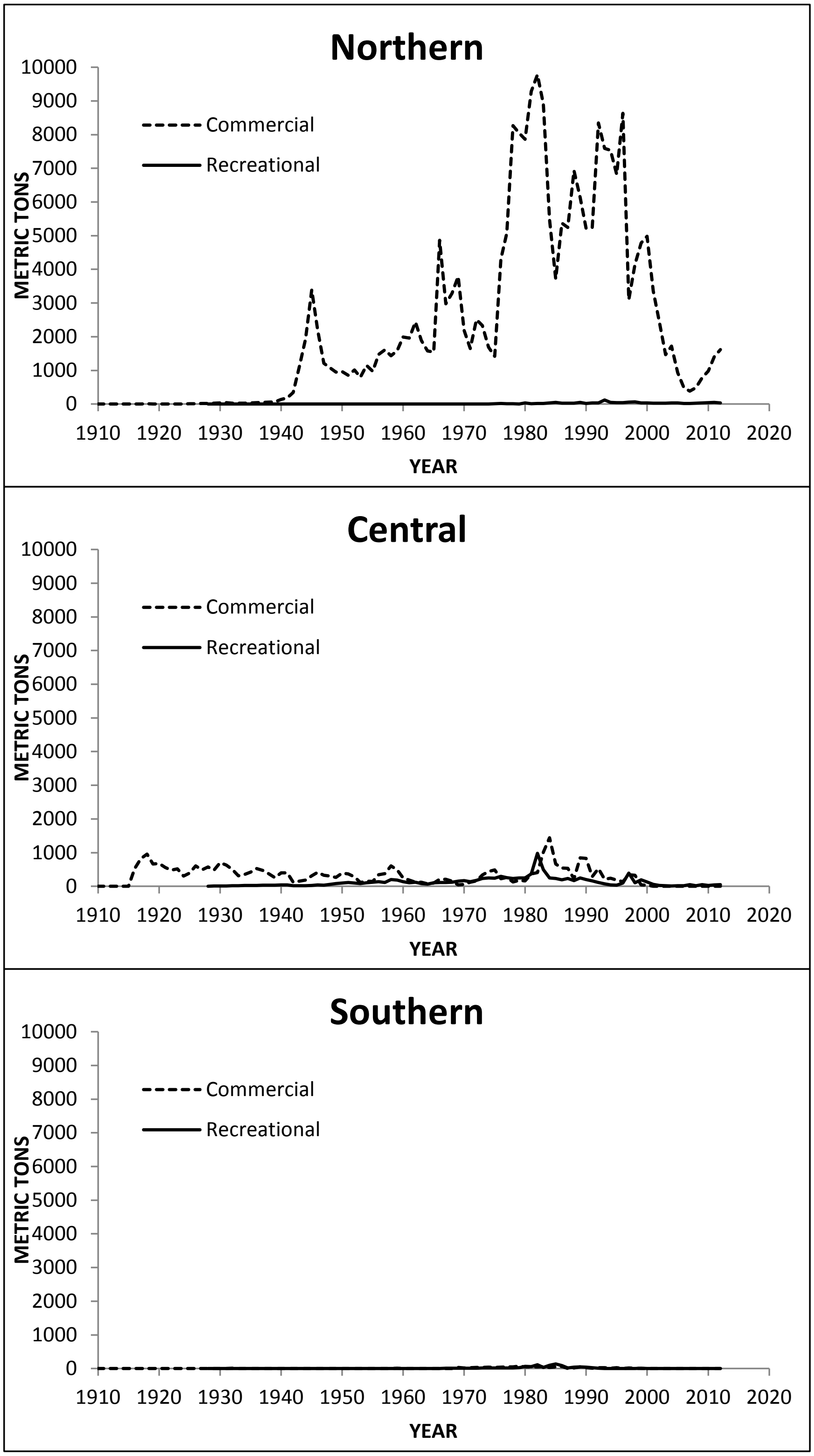

Figure 18. Yellowtail rockfish (*Sebastes flavidus*) catch by coastal region, year, and fishery. Coastal regions are divided at Point Conception and Cape Mendocino.

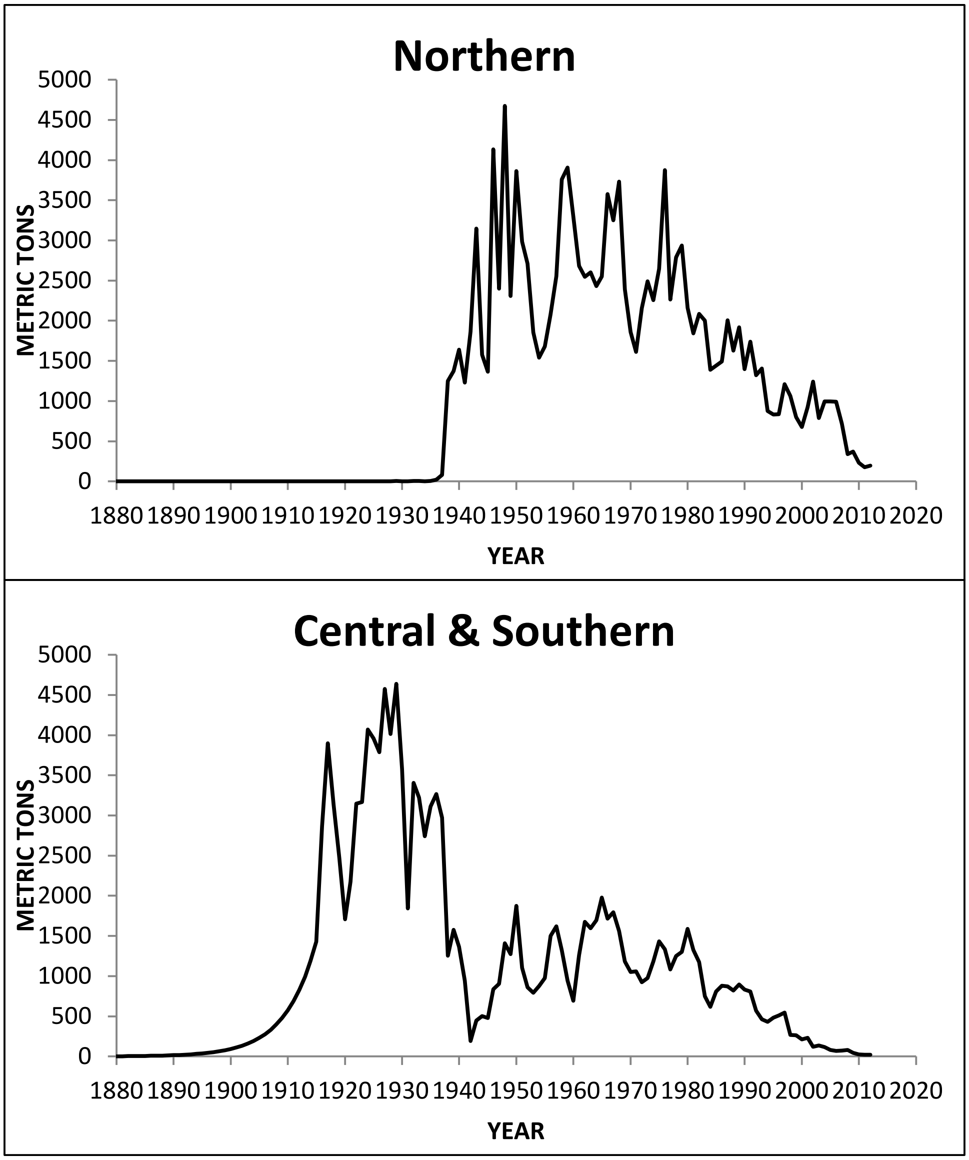

Figure 19. English sole (*Parophrys vetulus*) commercial landings by coastal region and year. Recreational catch is negligible. Commercial catch reconstructions (data prior to 2007) are from Stewart (2007), whose "Southern" area is equivalent to the Central and Southern areas in this assessment.

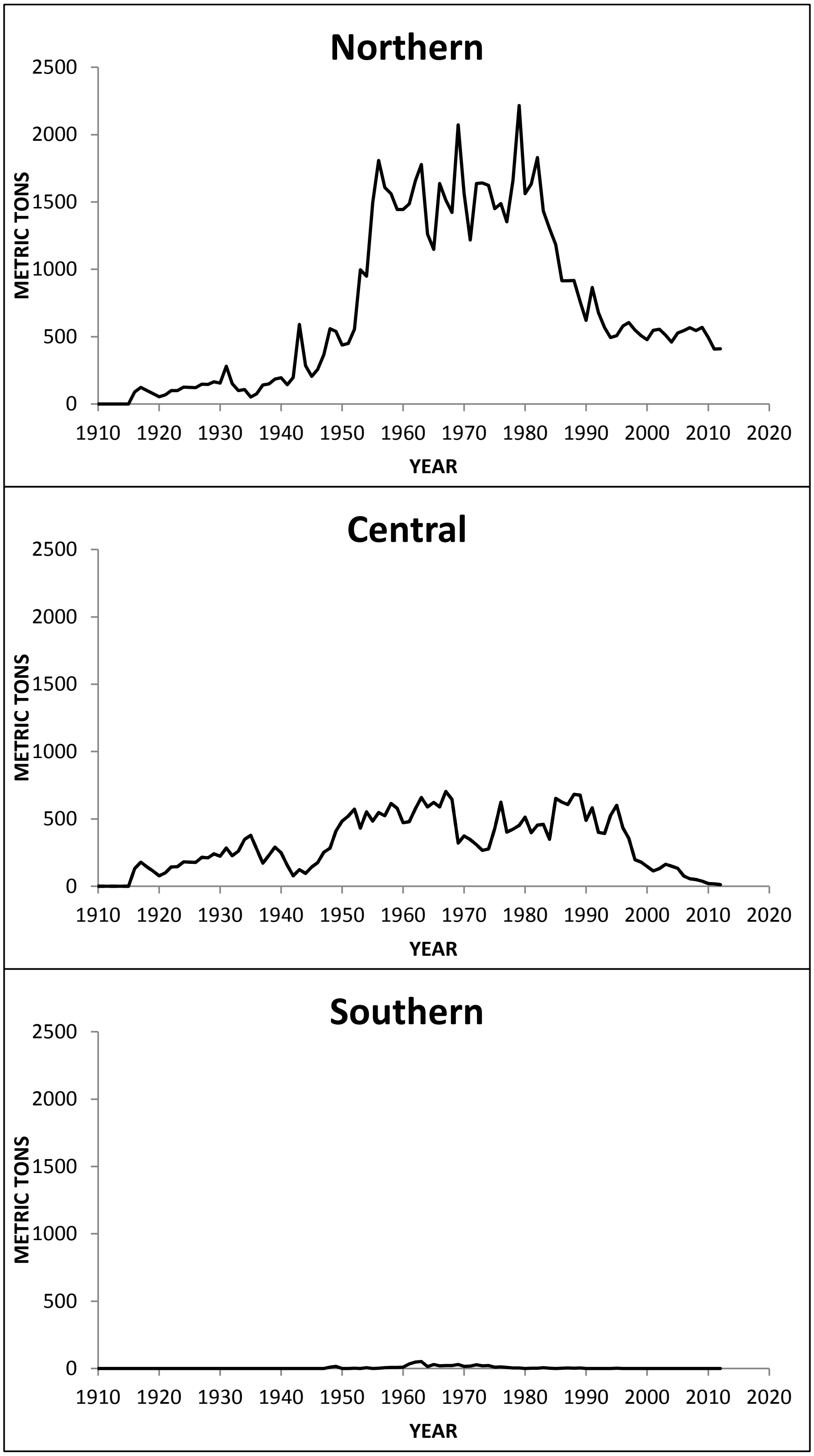

Figure 20. Rex sole (*Glyptocephalus zachirus*) commercial catch by coastal region and year. Recreational catch is negligible. Coastal regions are divided at Point Conception and Cape Mendocino

8.1.3 Indices of abundance

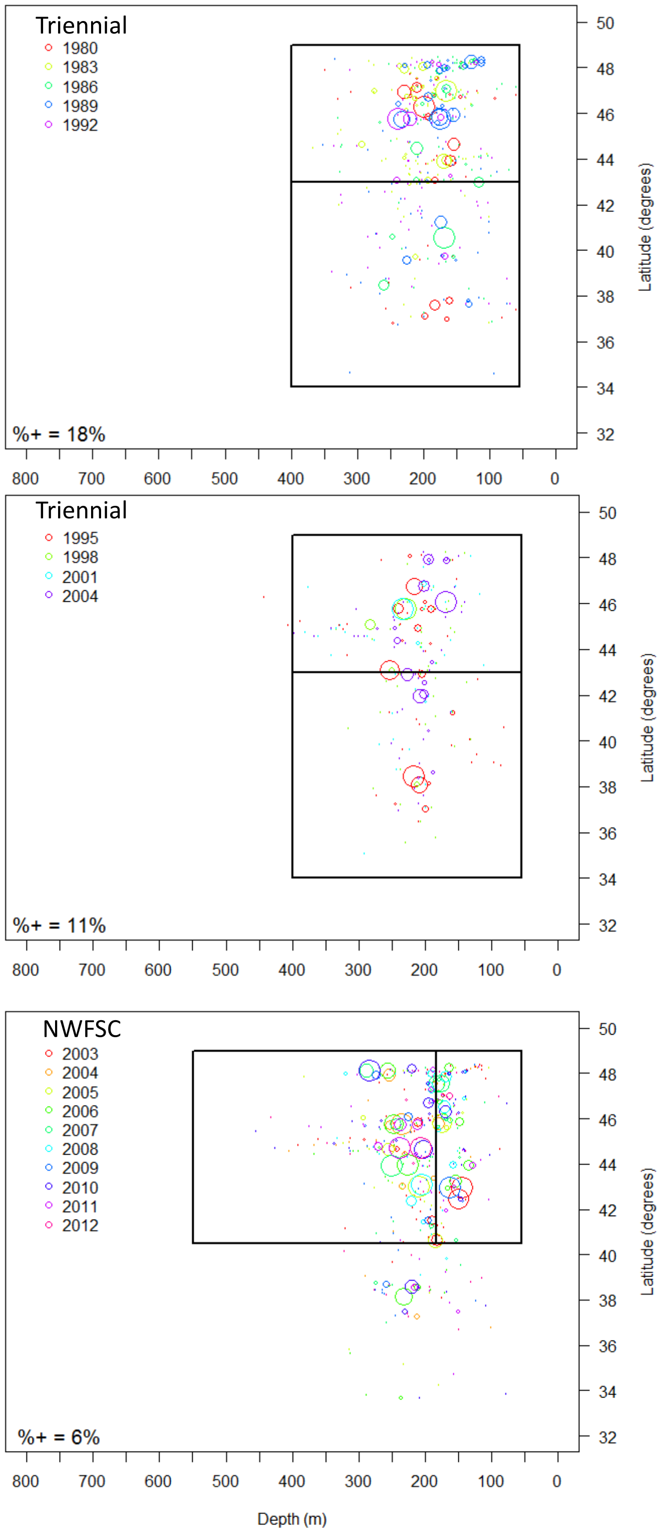

Figure 21. Depth and latitudinal occurrence of sharpchin rockfish in each trawl survey by year. Circle size indicates magnitude of catch. Black lines indicate the strata used in the GLMMs. Number in lower right is the percentage of positive tows.

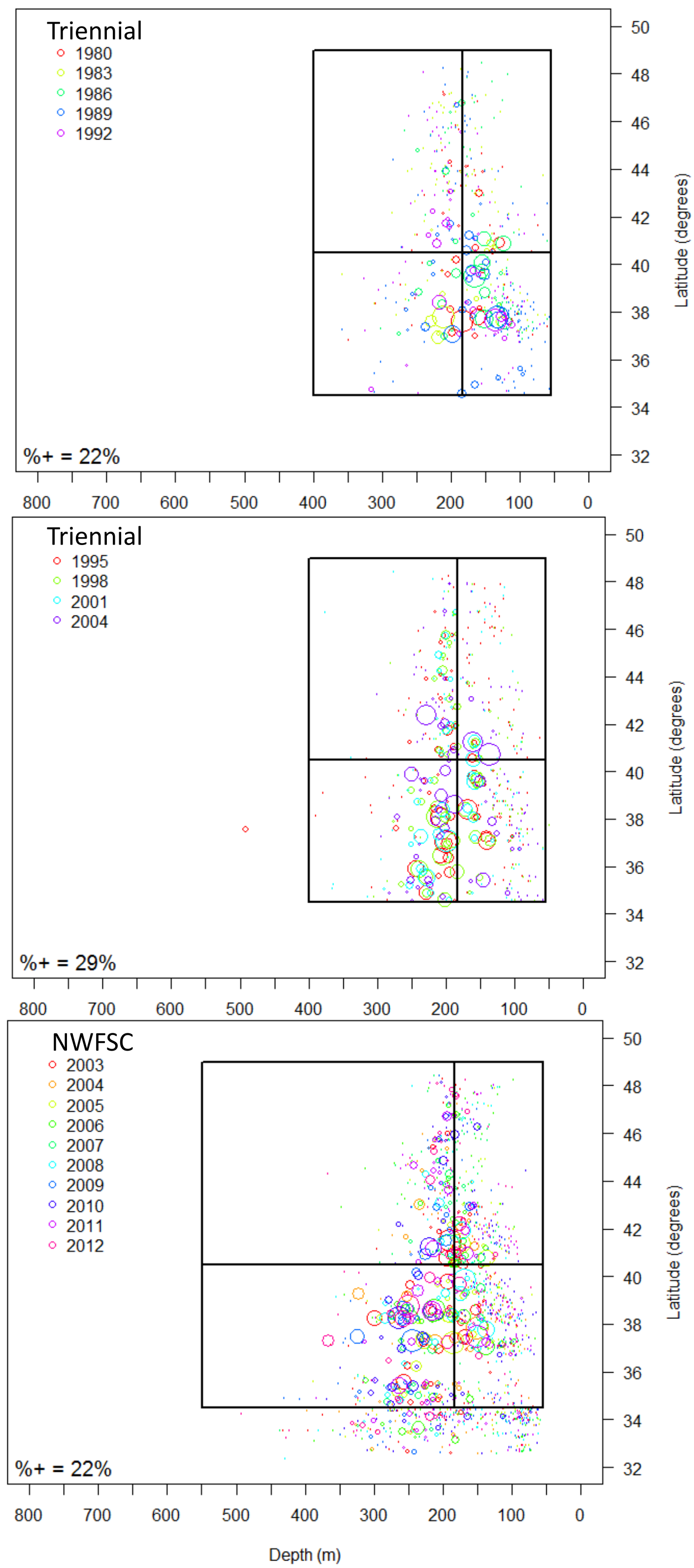

Figure 22. Depth and latitudinal occurrence of stripetail rockfish in each trawl survey by year. Circle size indicates magnitude of catch. Black lines indicate the strata used in the GLMMs. Number in lower right is the percentage of positive tows.

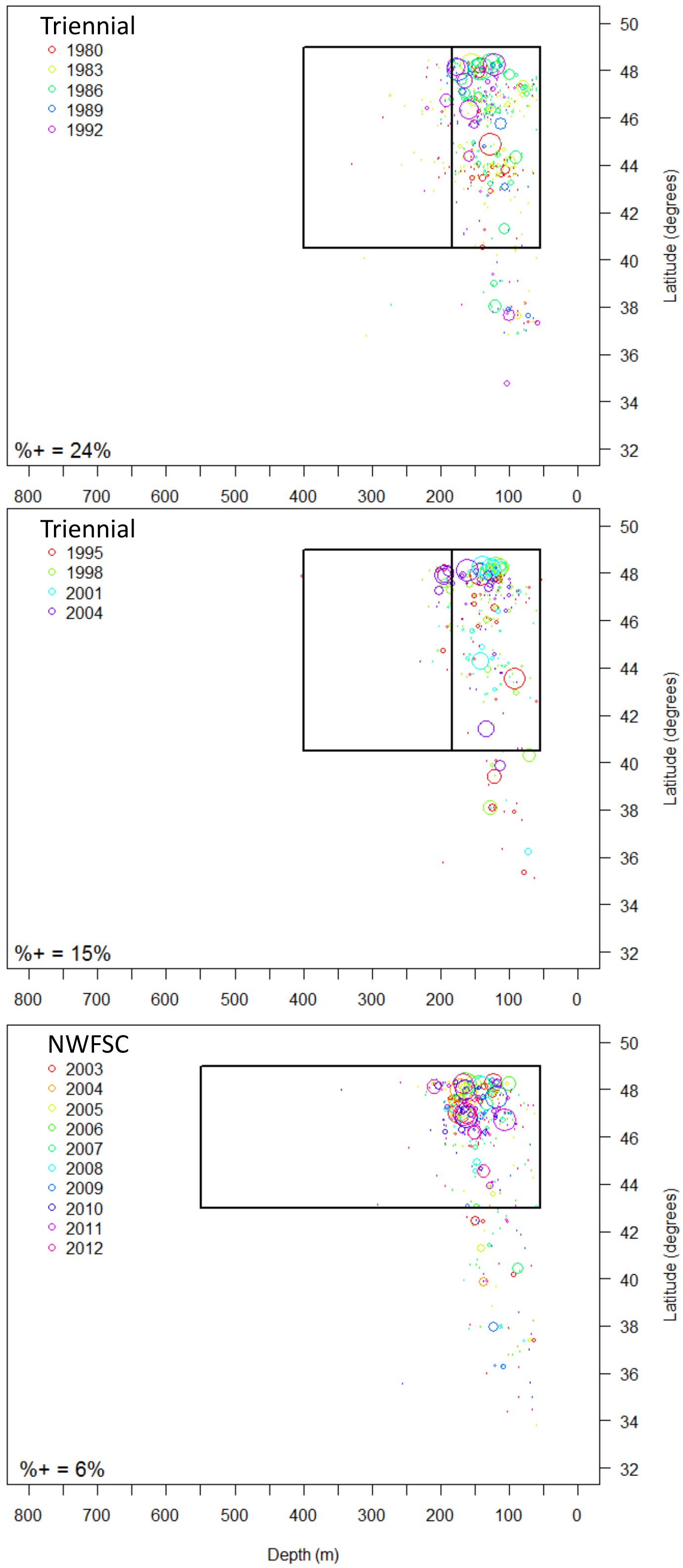

Figure 23. Depth and latitudinal occurrence of yellowtail rockfish (north of 40°10' N lat.) in each trawl survey by year. Circle size indicates magnitude of catch. Black lines indicate the strata used in the GLMMs. Number in lower right is the percentage of positive tows.

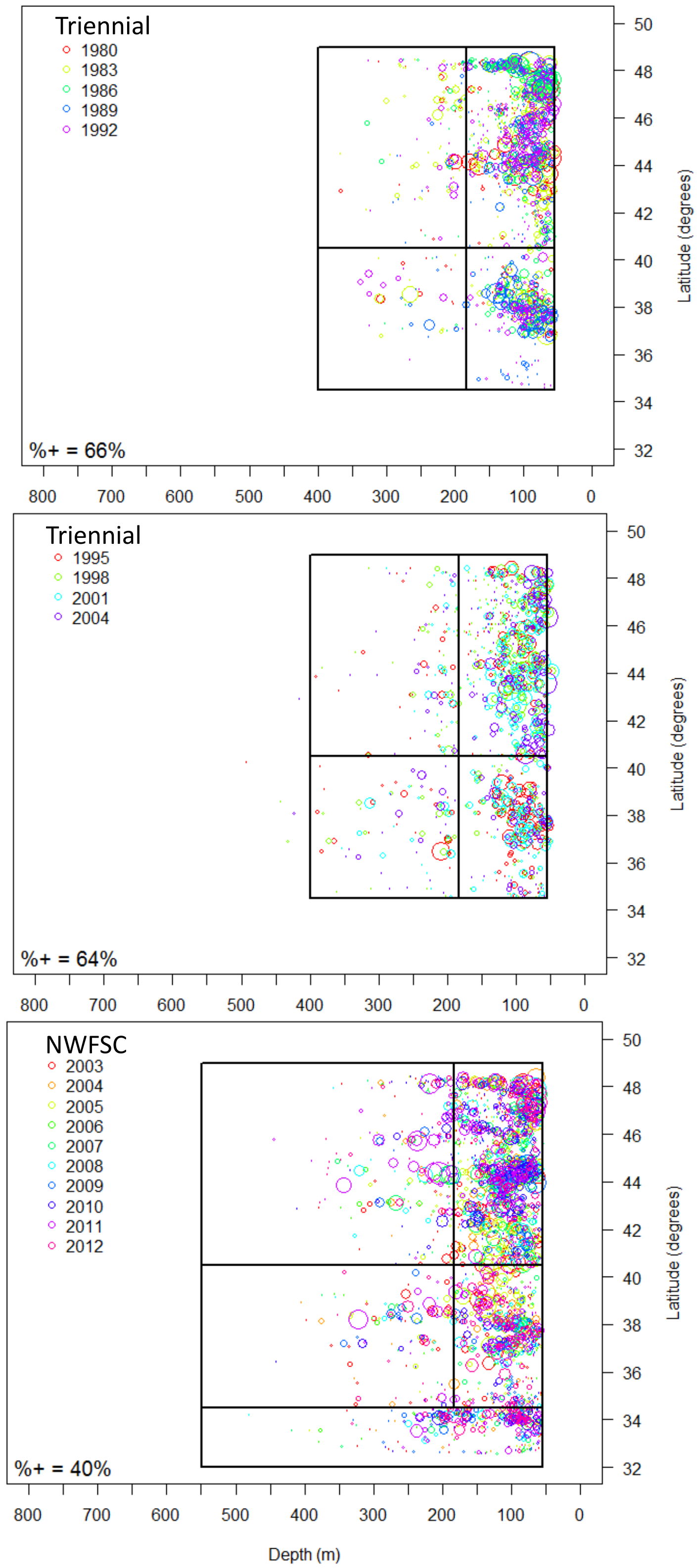

Figure 24. Depth and latitudinal occurrence of English sole in each trawl survey by year. Circle size indicates magnitude of catch. Black lines indicate the strata used in the GLMMs. Number in lower right is the percentage of positive tows.

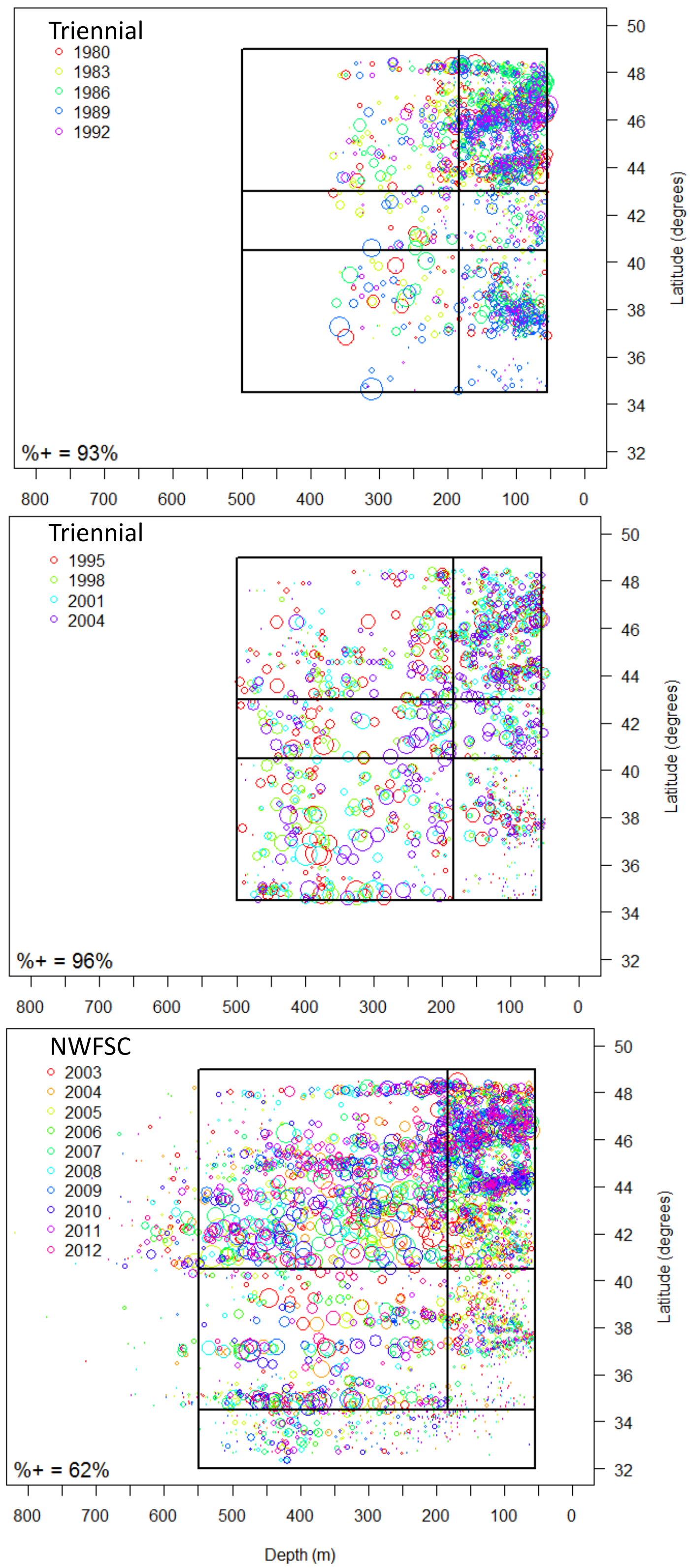

Figure 25. Depth and latitudinal occurrence of rex sole in each trawl survey by year. Circle size indicates magnitude of catch. Black lines indicate the strata used in the GLMMs. Number in lower right is the percentage of positive tows.

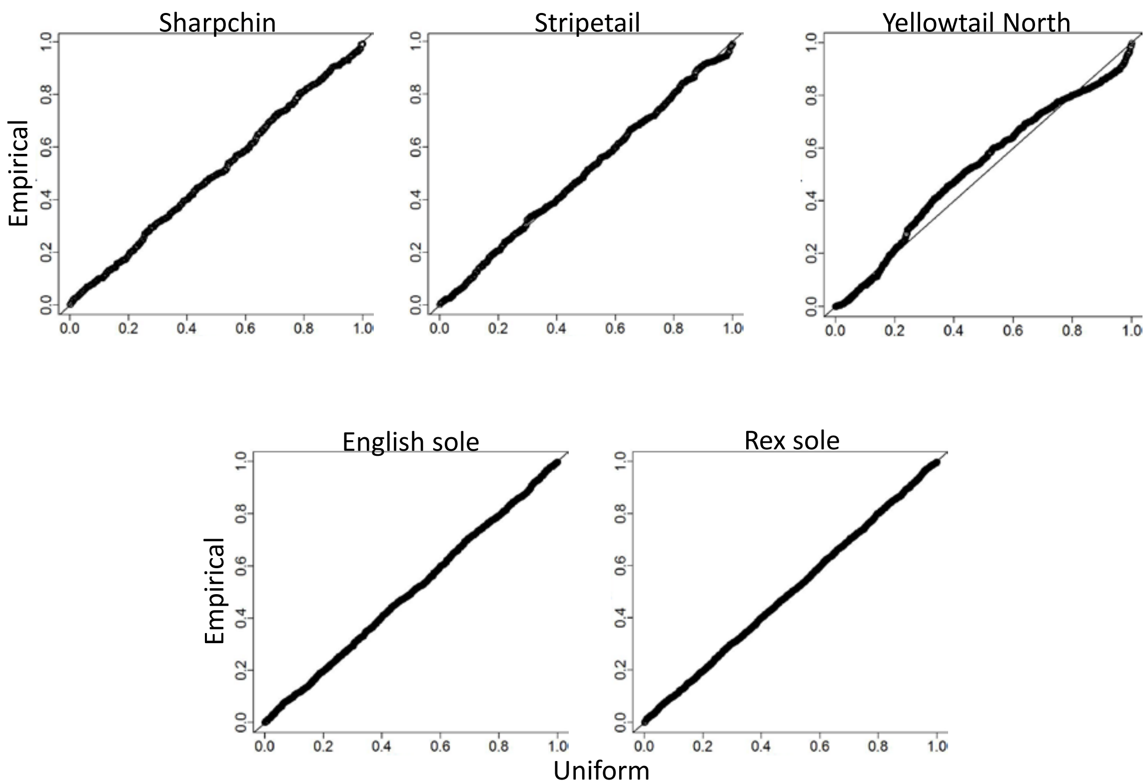

Figure 26. Q-Q plots for the early (1980-1992) AFSC triennial survey series used to diagnose convergence of the Bayesian GLMM model. The yellowtail rockfish (N) plot is for the full time series (1980-2004).

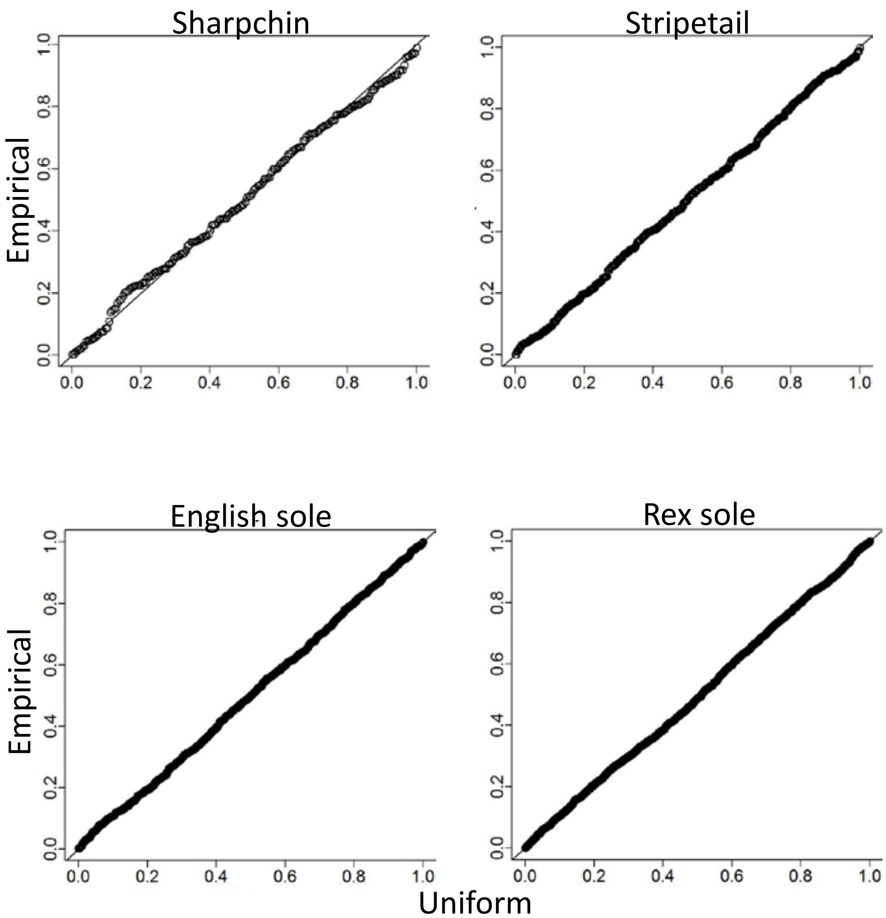

Figure 27. Q-Q plots for the late (1995-2004) AFSC triennial survey series used to diagnose convergence of the Bayesian GLMM model.

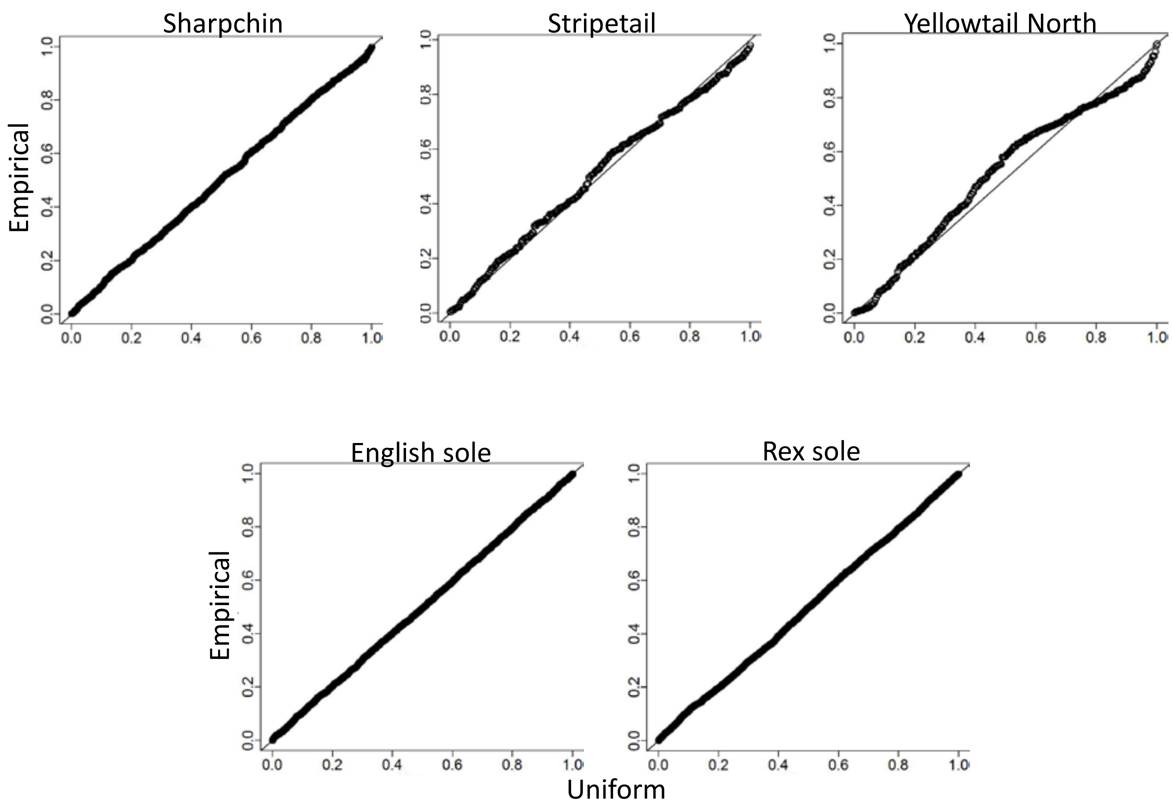

Figure 28. Q-Q plots for the NWFSC annual survey (2003-2012) series used to diagnose convergence of the Bayesian GLMM model.

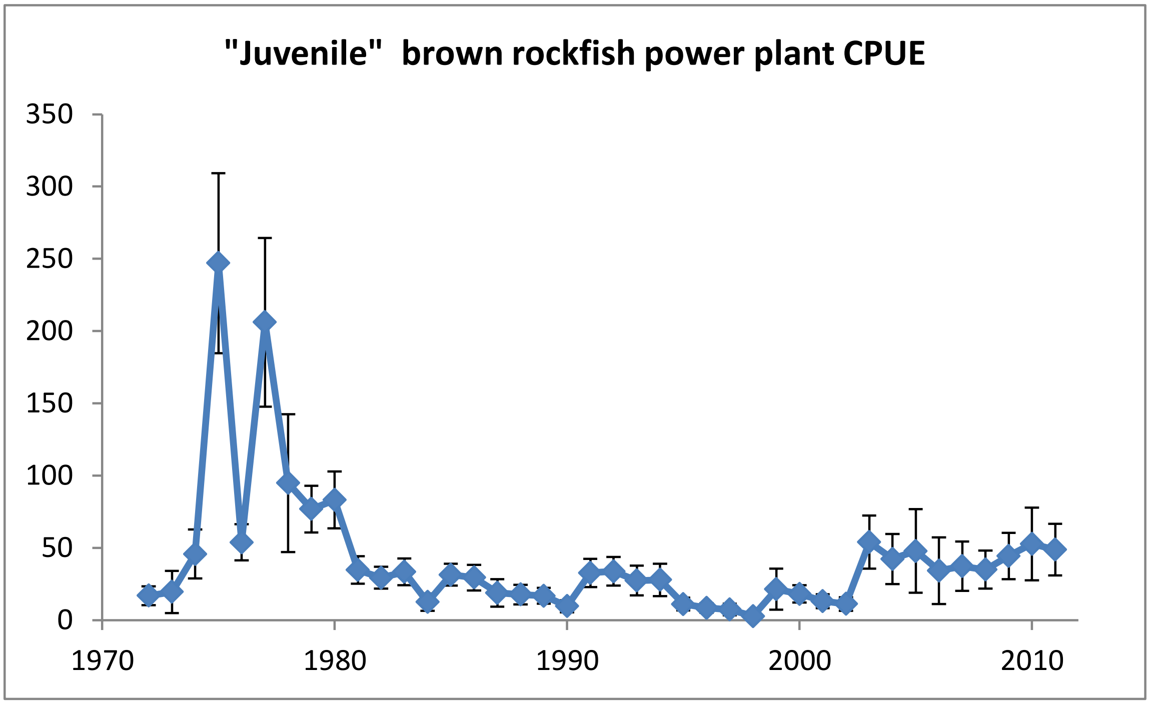

Figure 29. Preliminary index of Brown rockfish (*S. auriculatus*) based on the number of encountered animals; uncertainty based on a jackknife routine.

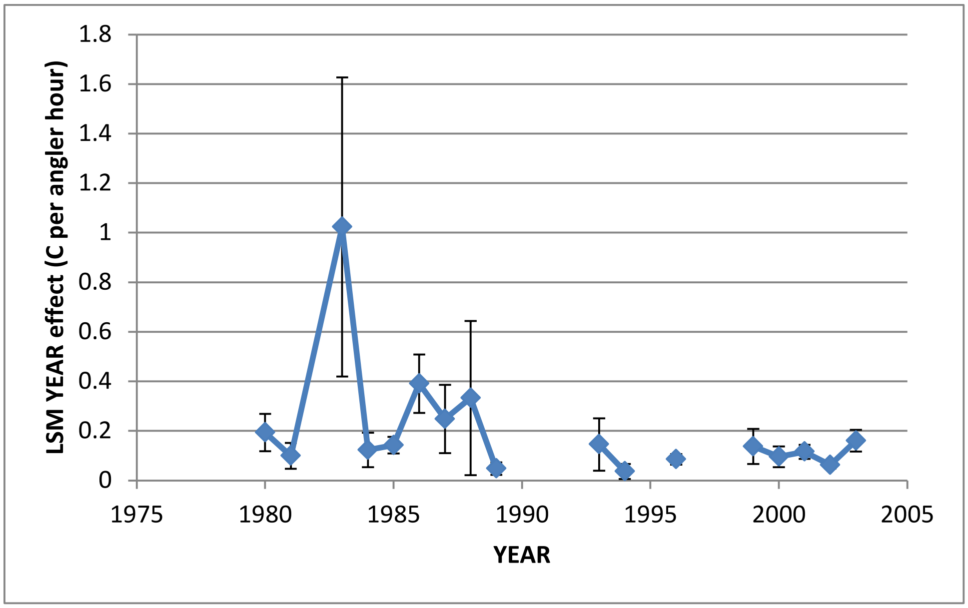

Figure 30. GLM time series of brown rockfish (central area) abundance indexes from RecFIN sampling. Error bars are 1 standard error from jackknife.

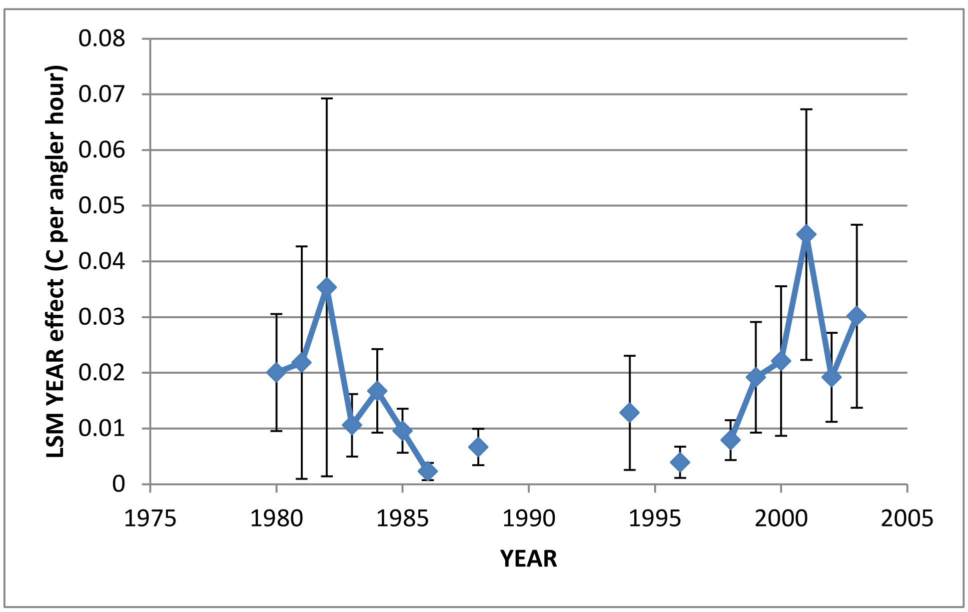

Figure 31. GLM time series of brown rockfish (southern area) abundance indexes from RecFIN sampling. Error bars are 1 standard error from jackknife.

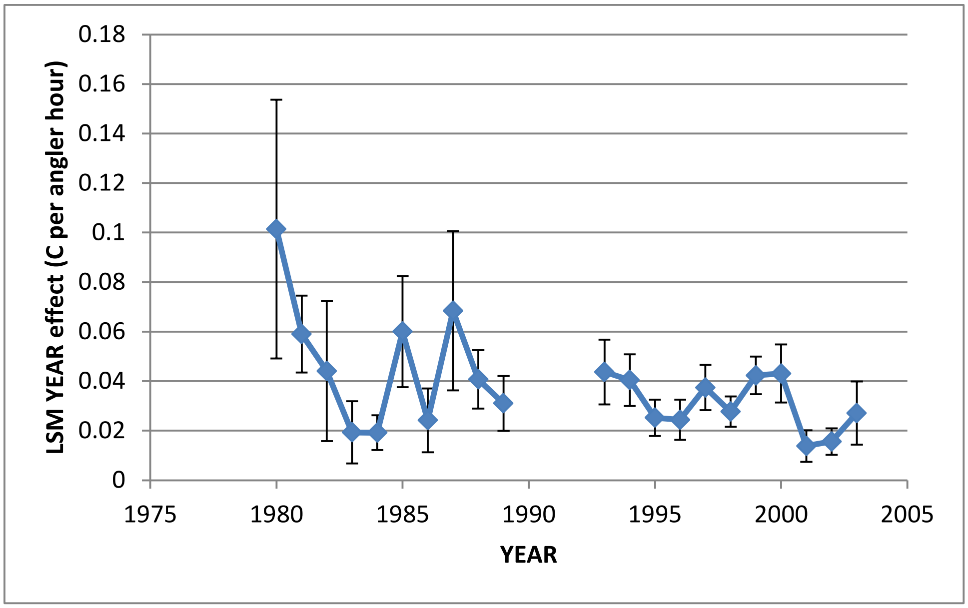

Figure 32. GLM time series of China rockfish (northern area) abundance indexes from RecFIN sampling. Error bars are 1 standard error from jackknife.

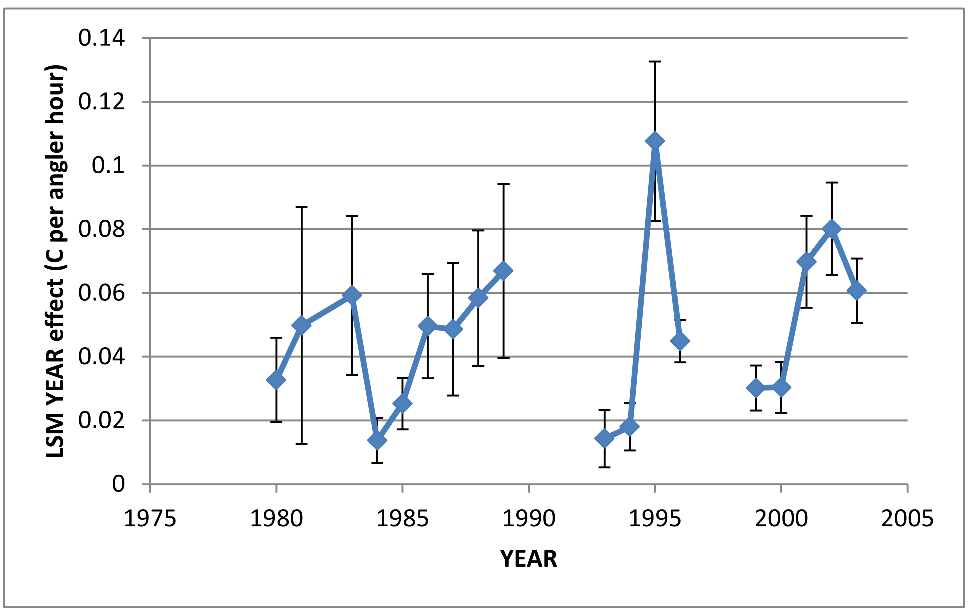

Figure 33. GLM time series of China rockfish (central area) abundance indexes from RecFIN sampling. Error bars are 1 standard error from jackknife.

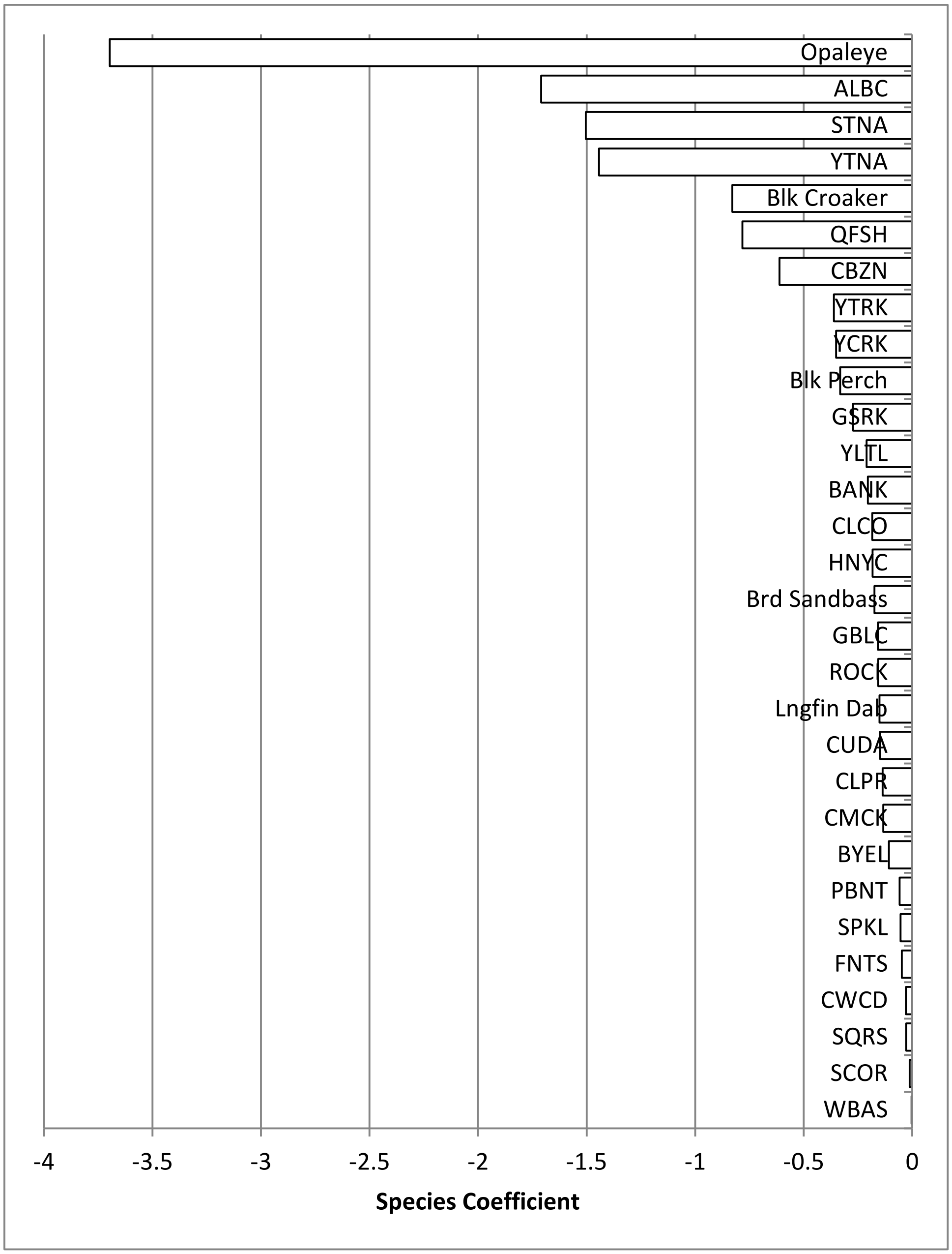

Figure 34. Coefficients (negative, i.e. species that are counter-indicators for copper rockfish in the landed catch) estimated by binomial regression for data filtering for copper rockfish south.

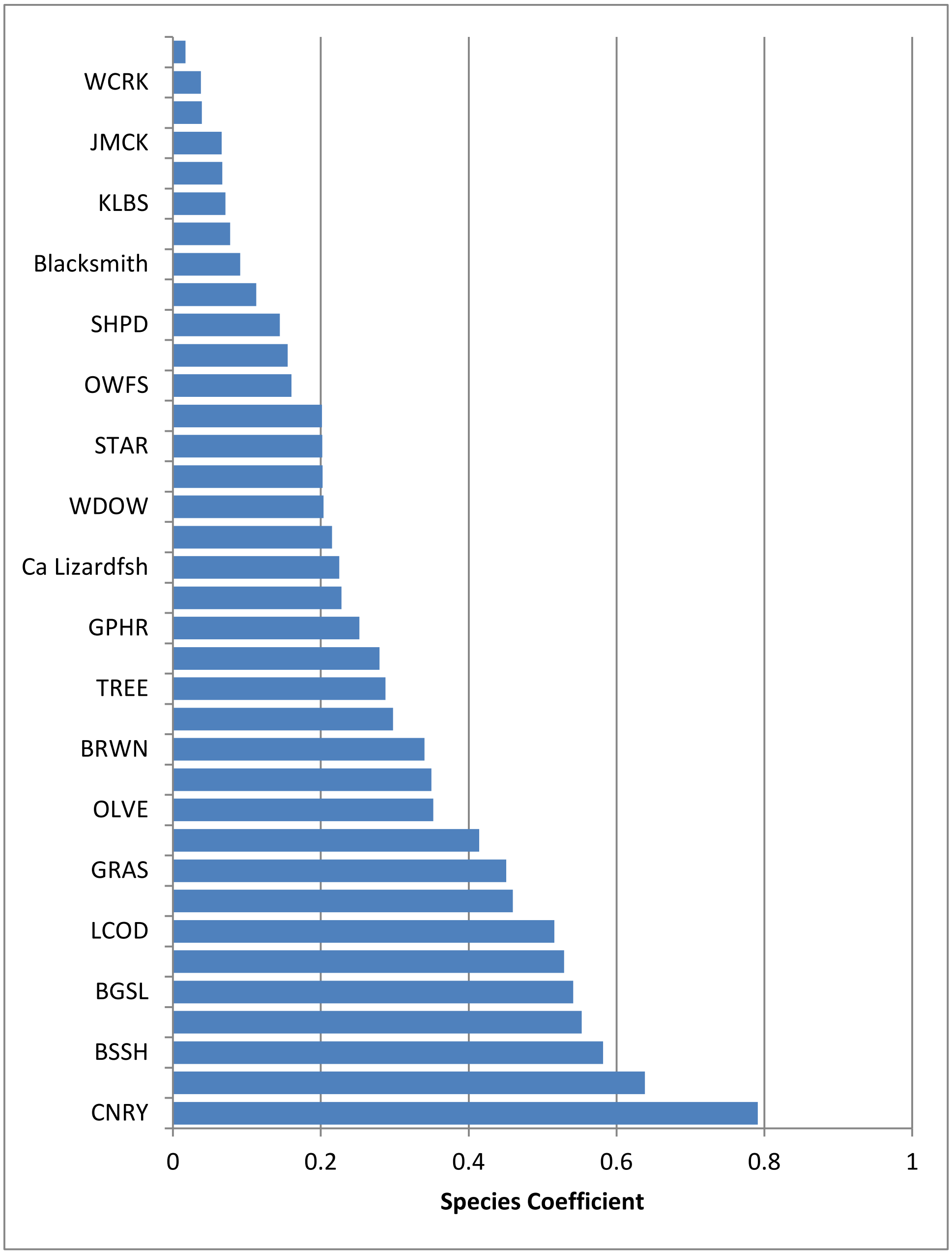

Figure 35. Coefficients (positive, i.e. species that co-occur with copper rockfish in the landed catch) estimated by binomial regression for data filtering for copper rockfish south.

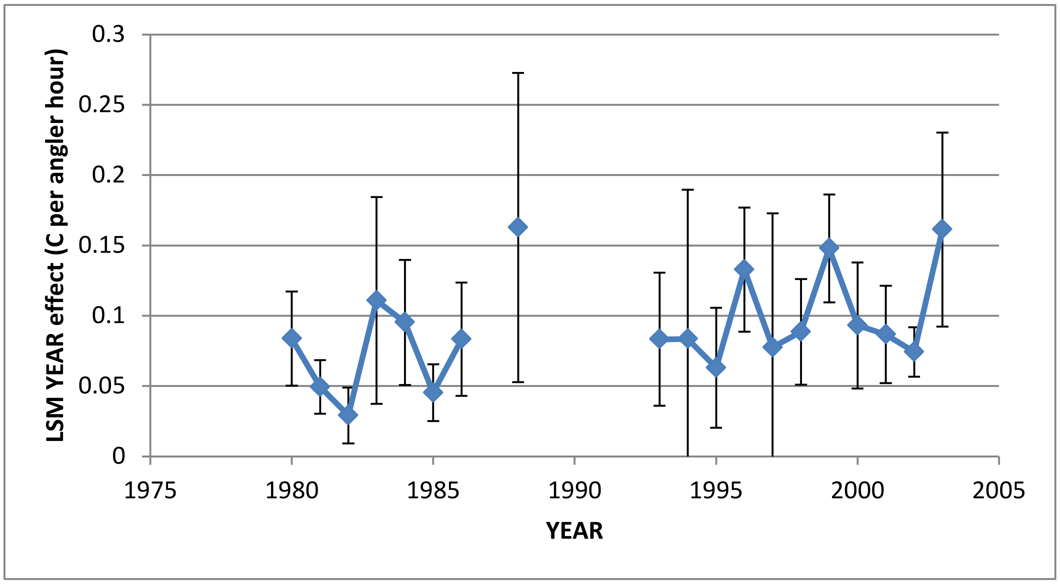

Figure 36. GLM time series of copper rockfish south abundance indexes from RecFIN sampling. Error bars are 1 standard error from jackknife.

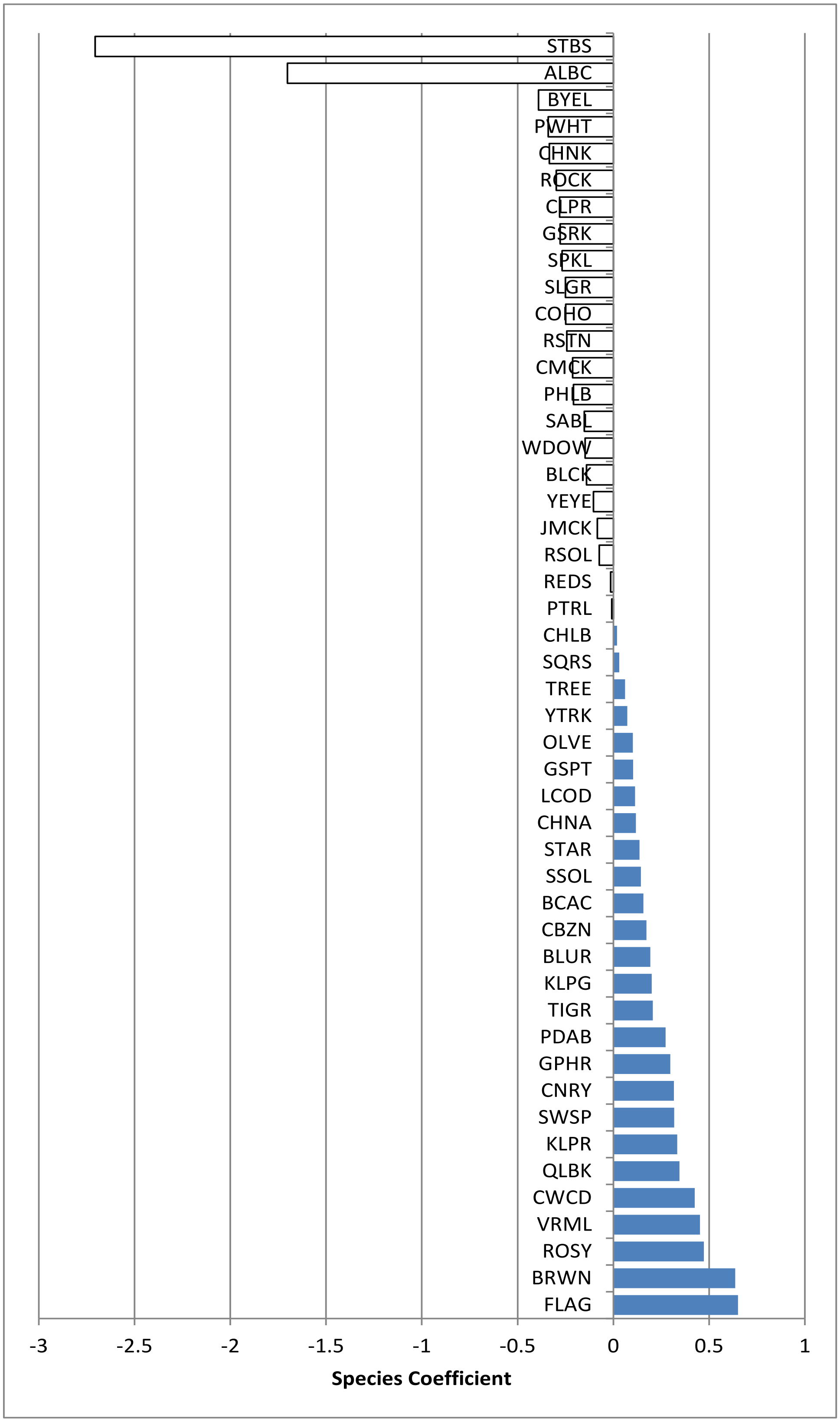

Figure 37. Coefficients estimated by binomial regression for data filtering copper rockfish north/central area.

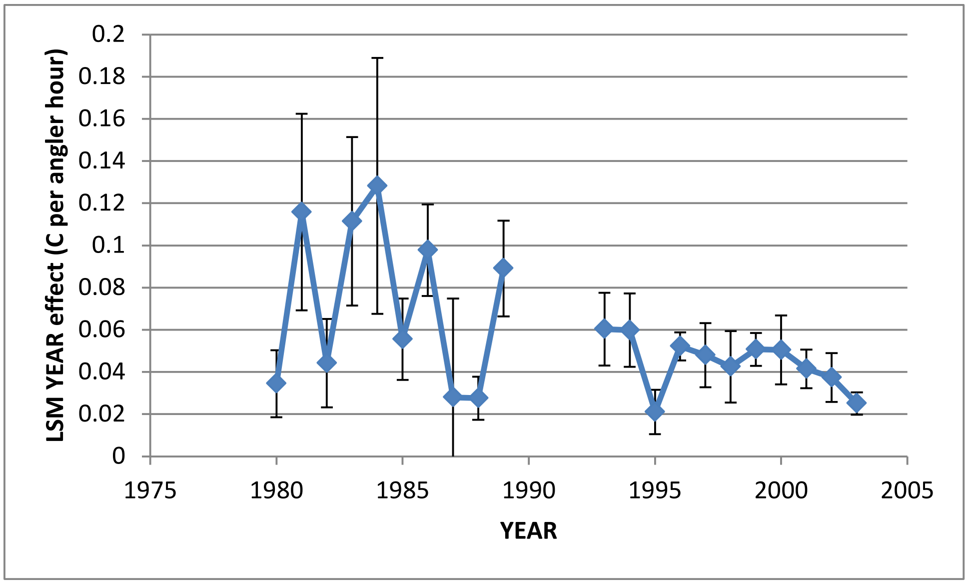

Figure 38. GLM time series of copper rockfish (north/central) abundance indexes from RecFIN sampling. Error bars are 1 standard error from jackknife.

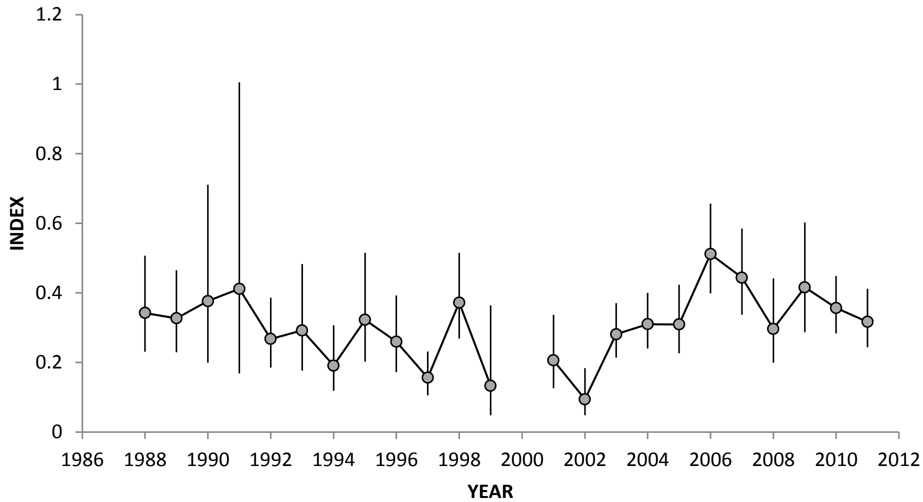

Figure 39. Year effects and 95% lognormal confidence intervals from the Central California onboard CPFV observer index for brown rockfish.

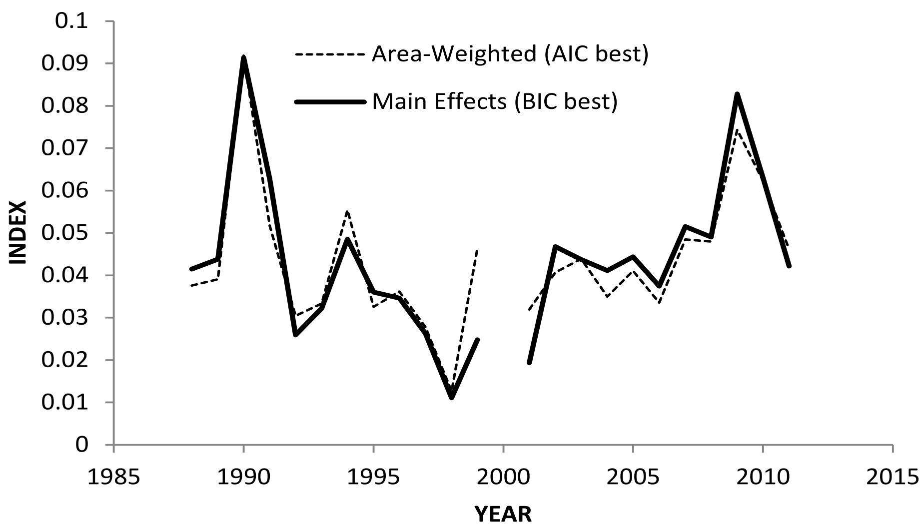

Figure 40. Comparison of area-weighted and “main effects” abundance indices for China rockfish in central California, estimated from onboard CPFV observer data.

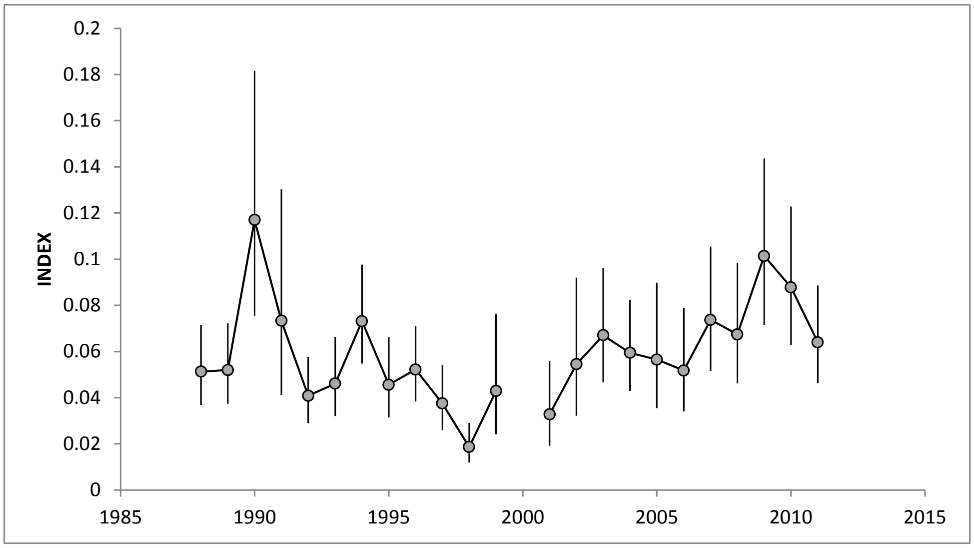

Figure 41. Year effects and 95% lognormal confidence intervals from the Central California onboard CPFV observer index for China rockfish.

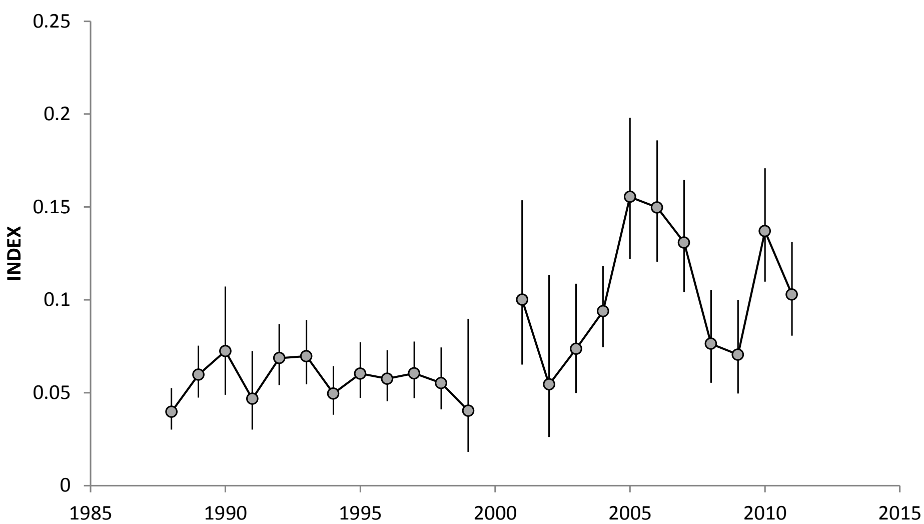

Figure 42. Year effects and 95% lognormal confidence intervals from the Central California onboard CPFV observer index for copper rockfish.

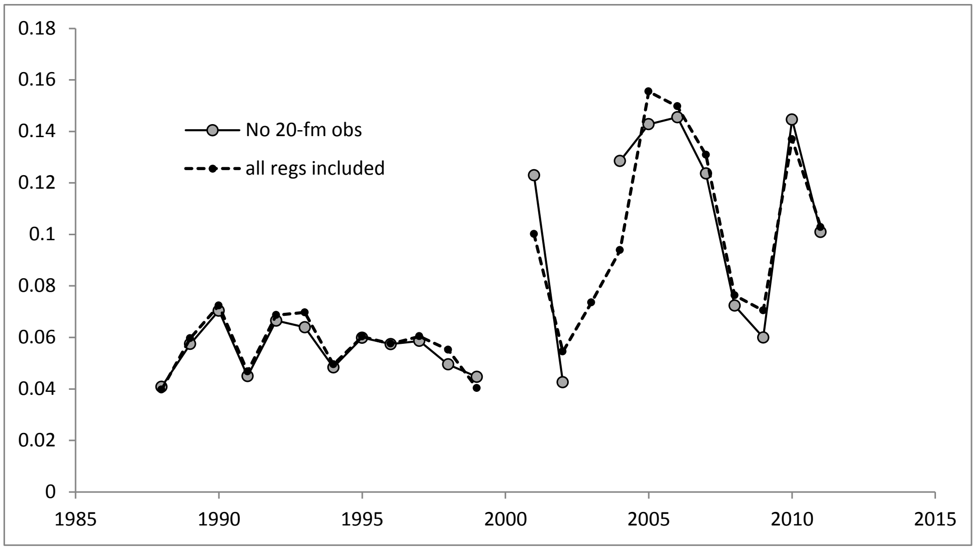

Figure 43. Year effects from the Central California onboard CPFV observer index for copper rockfish, with a comparison of indices derived using data from all regulatory periods ("all regs included") and data excluding locations and time periods with 20-fathom depth restrictions ("No 20-fm obs").

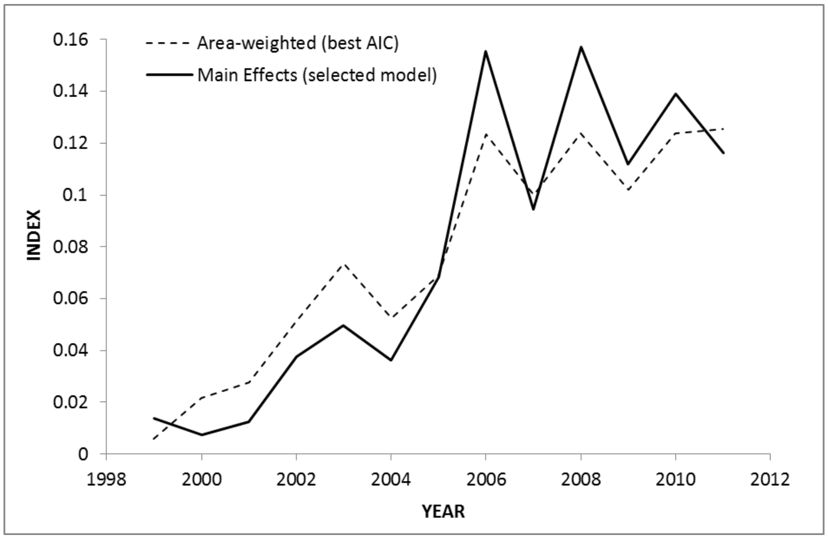

Figure 44. Comparison of indices for Southern California onboard CPFV observer indices for brown rockfish. An area-weighted year/region interaction term (dashed line; selected by AIC) and main-effects model (solid line; selected by AIC without interactions).

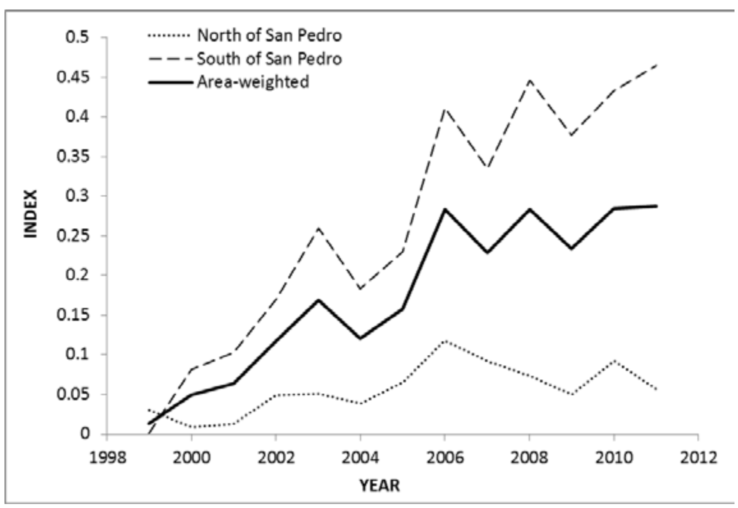

Figure 45. Comparison of indices for Southern California onboard CPFV observer for drifts north of San Pedro (dotted line) and south of San Pedro (dashed line) to the area-weighted index.

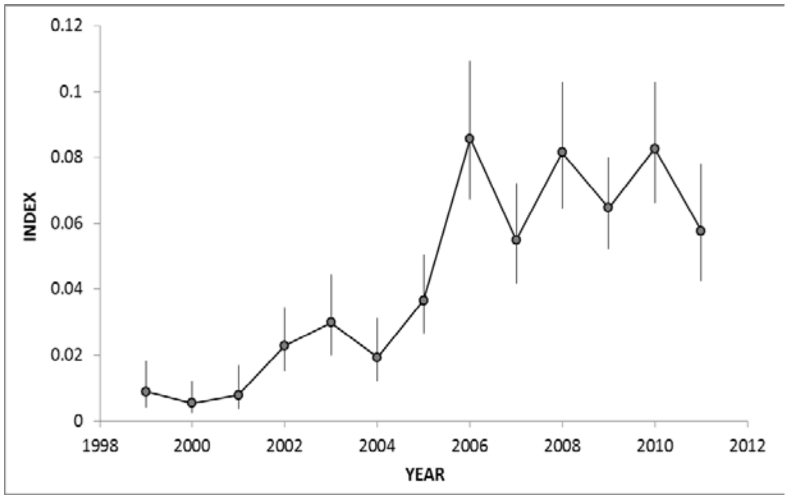

Figure 46. Year effects and 95% lognormal confidence intervals from the Southern California onboard CPFV observer index for brown rockfish.

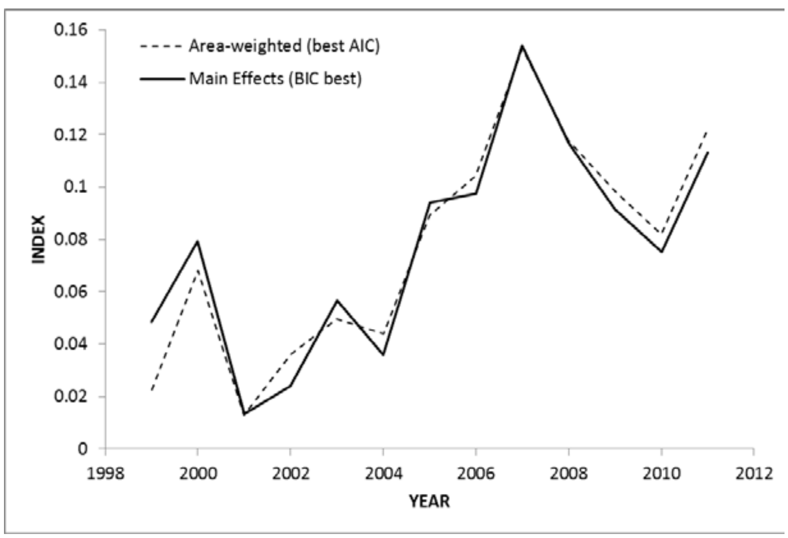

Figure 47. Comparison of indices for Southern California onboard CPFV observer indices for copper rockfish. An area-weighted year/region interaction term (dashed line; selected by AIC) and main-effects model (solid line; selected by BIC without interactions).

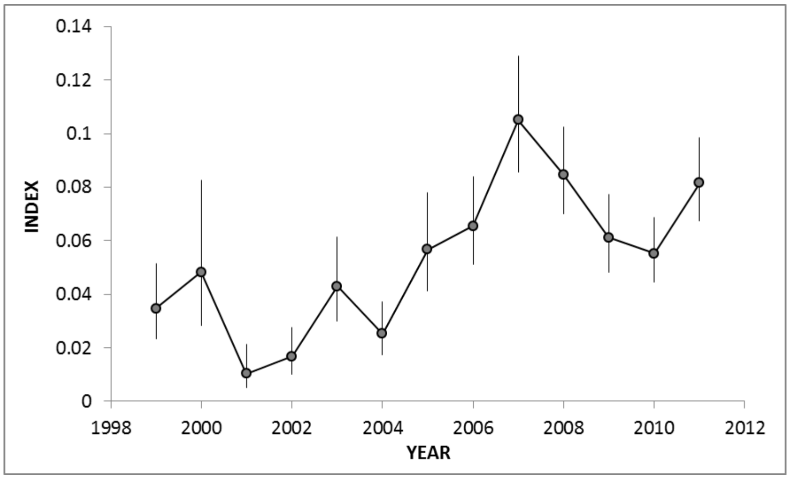

Figure 48. Year effects and 95% lognormal confidence intervals from the Northern California/Oregon onboard CPFV observer index for copper rockfish.

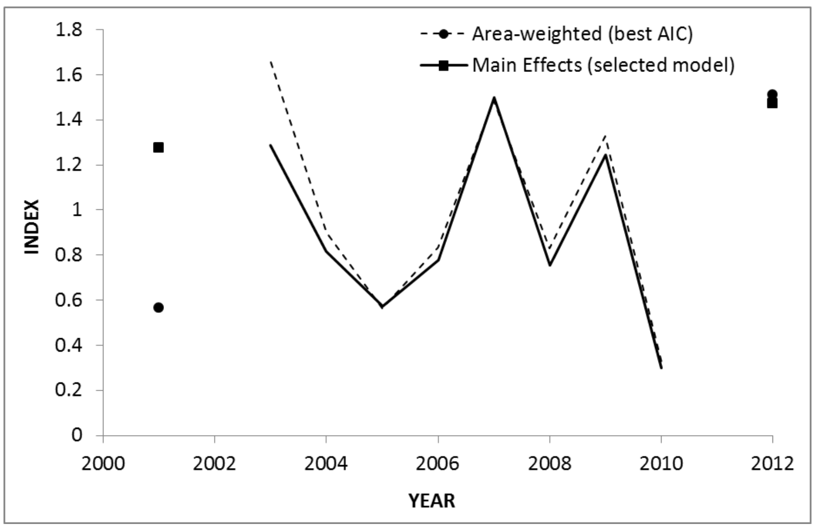

Figure 49. Comparison of indices for the Northern California /Oregon onboard CPFV observer indices for China rockfish. An area-weighted year/region interaction term (dashed line; selected by AIC) and main-effects model (solid line; selected model).

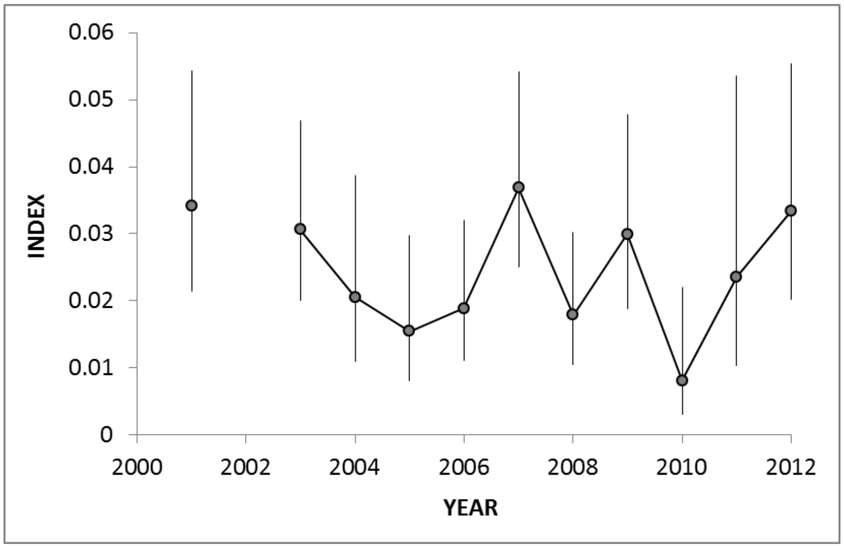

Figure 50. Year effects and 95% lognormal confidence intervals from the Northern California/Oregon onboard CPFV observer index for China rockfish.

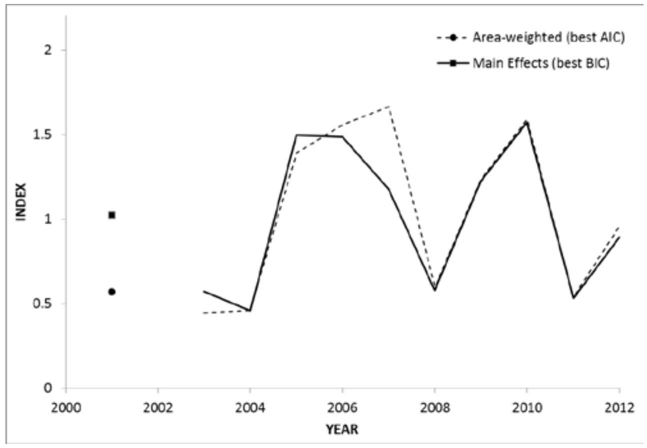

Figure 51. Comparison of indices for the Northern California /Oregon onboard CPFV observer indices for copper rockfish. An area-weighted year/region interaction term (dashed line; selected by AIC) and main-effects model (solid line; selected model).

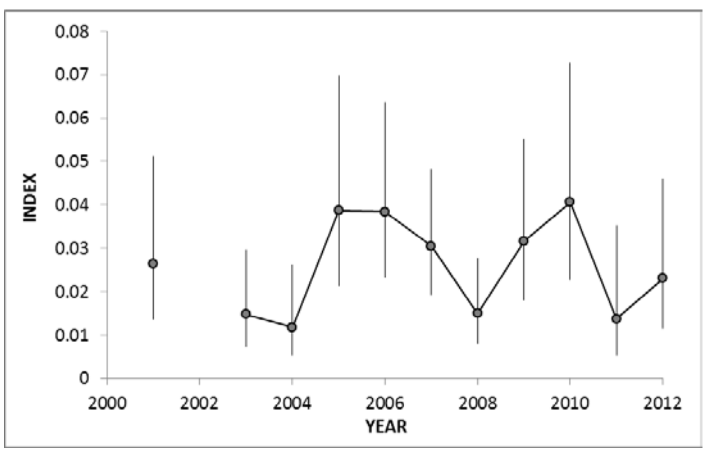

Figure 52. Year effects and 95% lognormal confidence intervals from the Northern California/Oregon onboard CPFV observer index for copper rockfish.

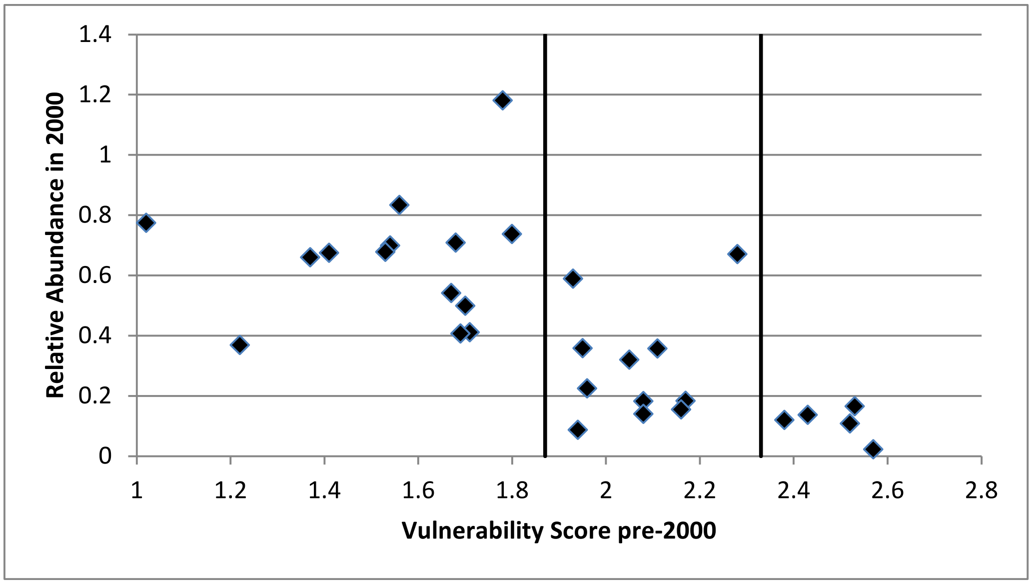

Figure 53. The relationship between relative abundance in 2000 ($B_{2000}/B_{unfished}$) and a PSA vulnerability score reflecting pre-2000 fishery management.

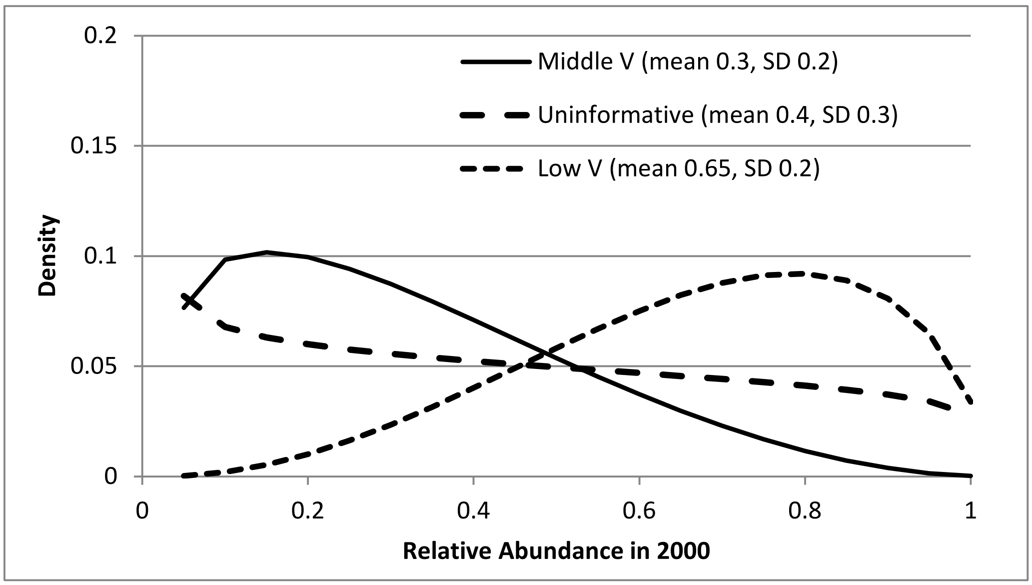

Figure 54. Prior distributions for alternative vulnerability scores.

8.2 Model Results and Diagnostic Figures

8.2.1 Brown rockfish

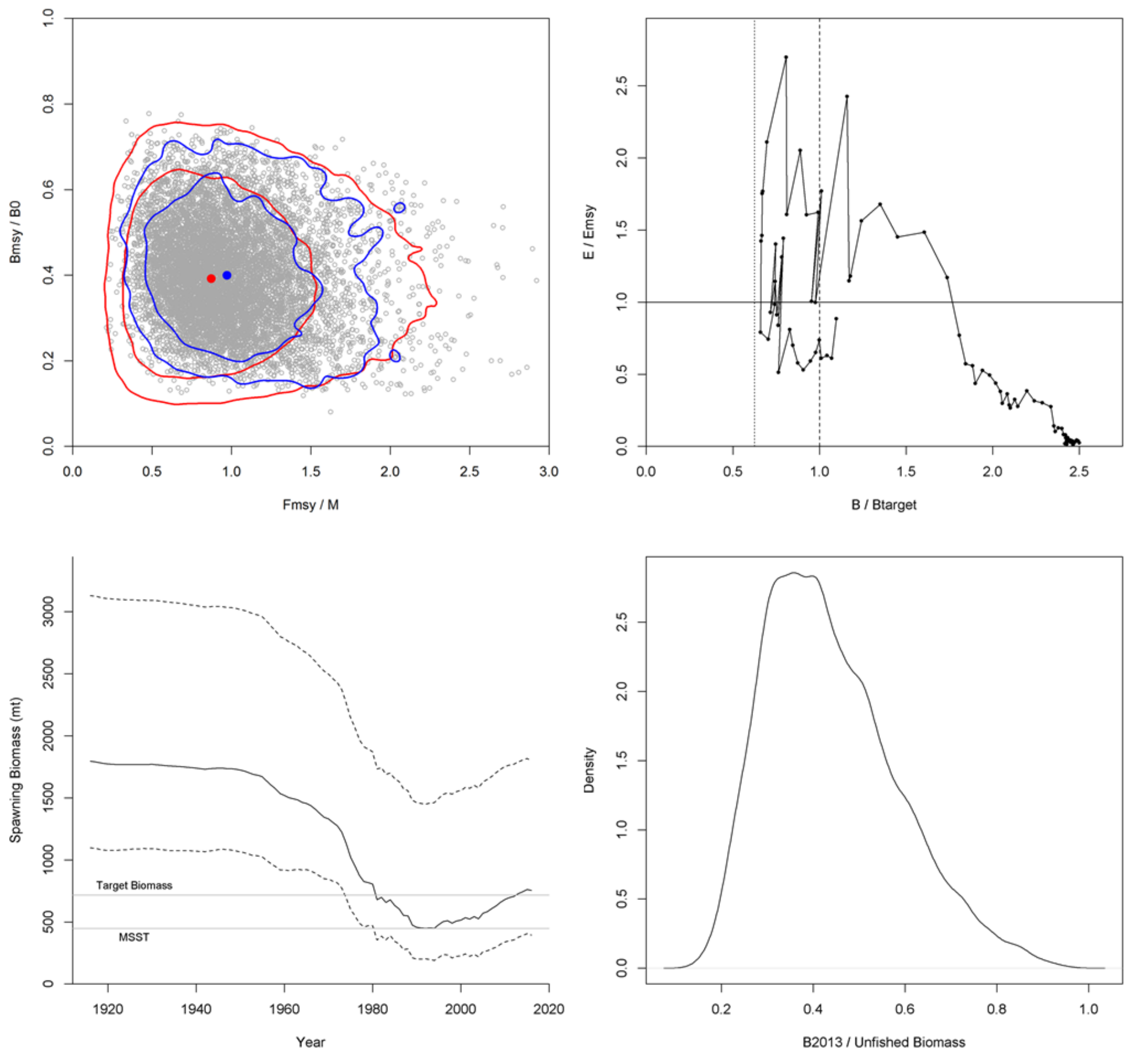

Figure 55. XDB-SRA results for brown rockfish. Upper left: bivariate prior and posterior distributions for F_{MSY}/M and B_{MSY}/B_0. Red lines are 75% and 95% contours of the prior, blue lines are updated posterior contours. Grey circles are posterior draws, large solid circles are centroids (medians) of the prior and posterior (red and blue, respectively). Upper right: trends in relative exploitation rate and relative biomass. Horizontal solid line is target exploitation rate (model-estimated), vertical lines (dashed and dotted) are target and threshold biomass values, $0.4B_0$ and $0.25B_0$, respectively. Lower left: Median, 5% and 95% quantiles of spawning biomass relative to target and minimum stock size threshold (MSST). Lower right: posterior density of current depletion (biomass in 2013 relative to unfished biomass).

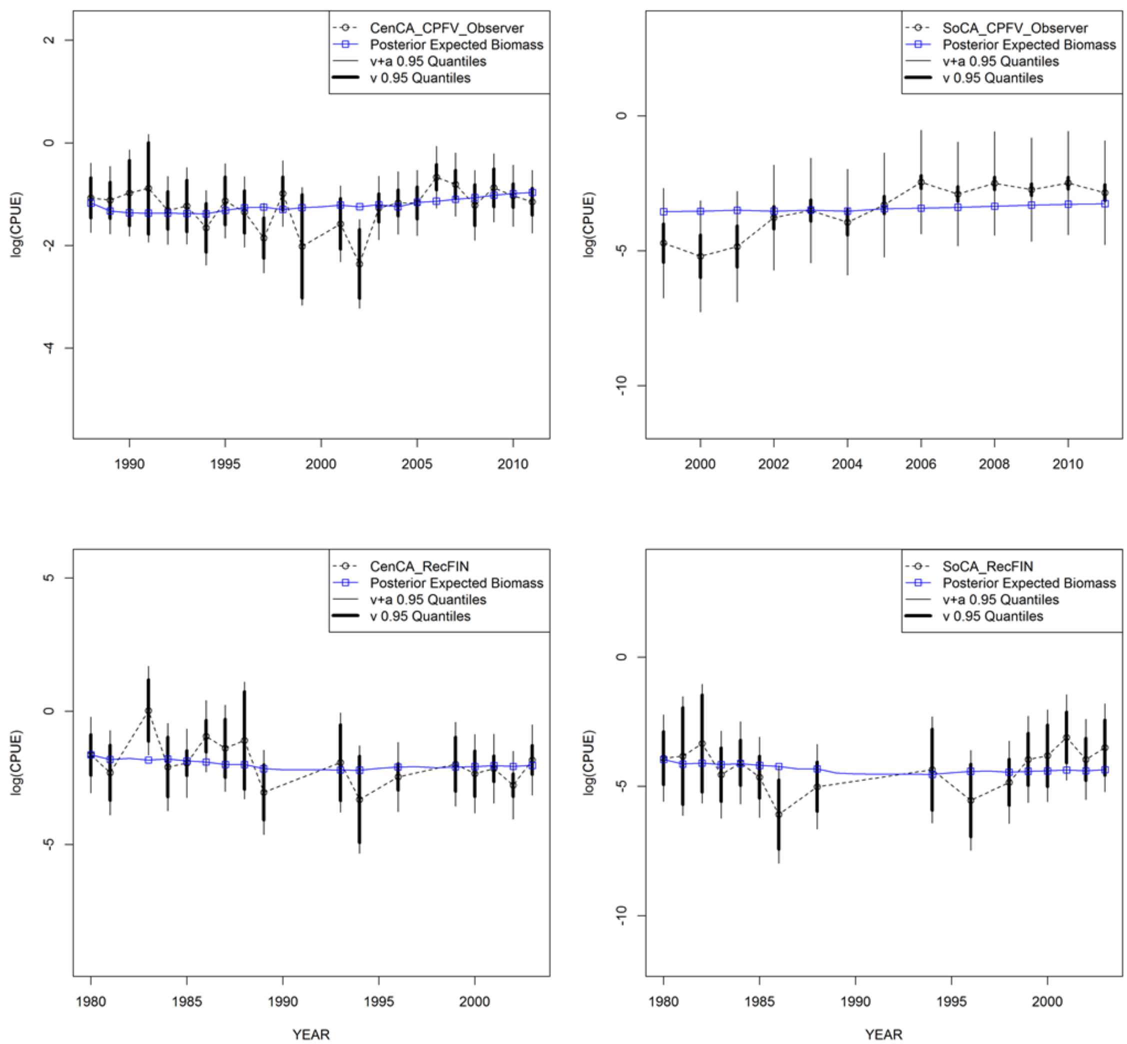

Figure 56. Fits of log-scale indices for brown rockfish to XDB-SRA biomass trajectories. Upper left: Central California onboard CPFV observer index. Upper right: Southern California onboard CPFV observer index. Lower left: Central California RecFIN dockside index. Lower right: Southern California RecFIN dockside index. Vertical lines are 95% intervals based on the input variance (thick portion) and combined variance (input plus additive) components (thin portion). Solid blue line is expected (log-scale) biomass, scaled for comparison.

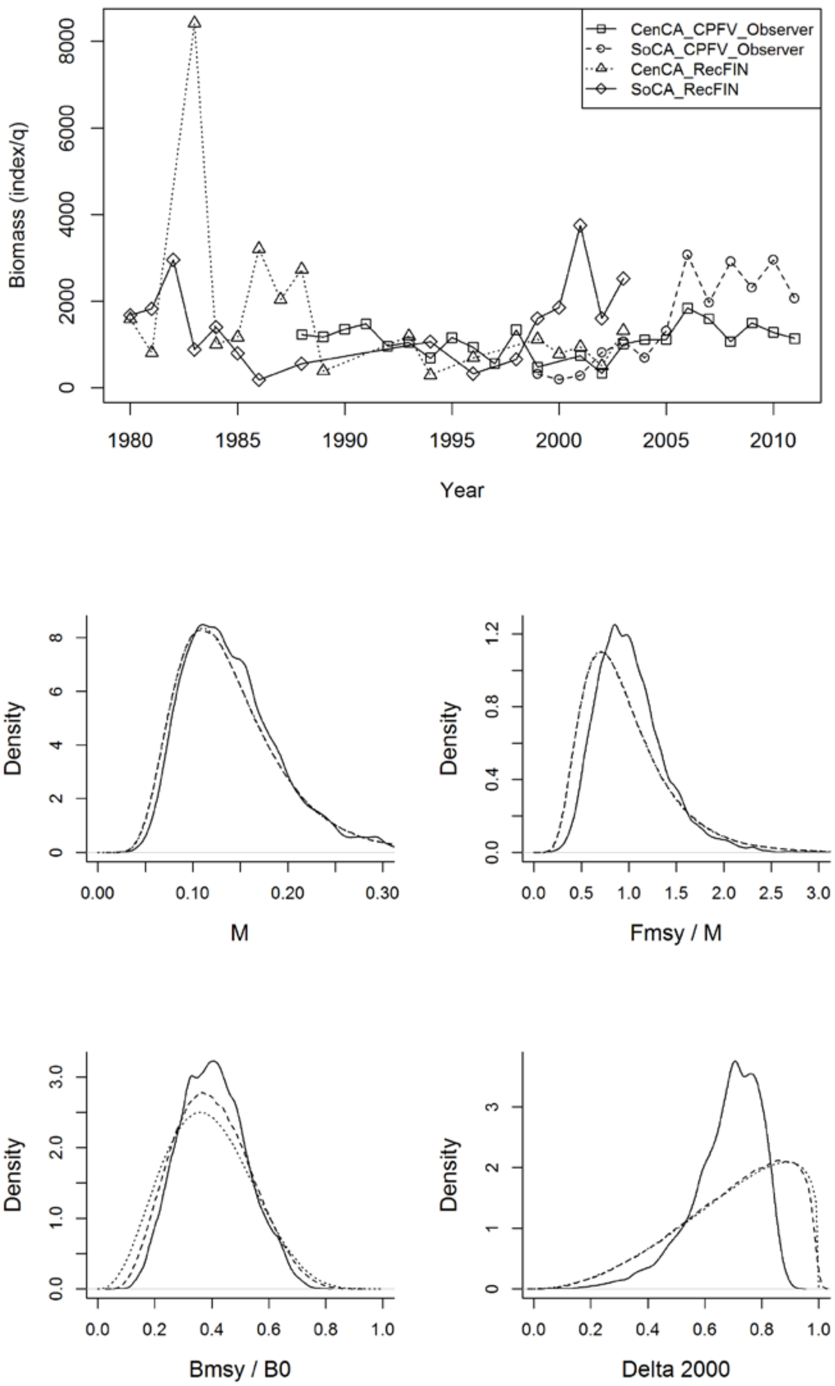

Figure 57. XDB-SRA results for brown rockfish (coastwide). <u>Top panel</u>: indices of abundance rescaled into biomass units (see previous figure for index descriptions). <u>Bottom panels</u>: prior (dotted), post-model pre-data (dashed), and posterior (solid) distributions of XDB-SRA population dynamics parameters.

8.2.2 China rockfish

8.2.2.1 Central and Southern California

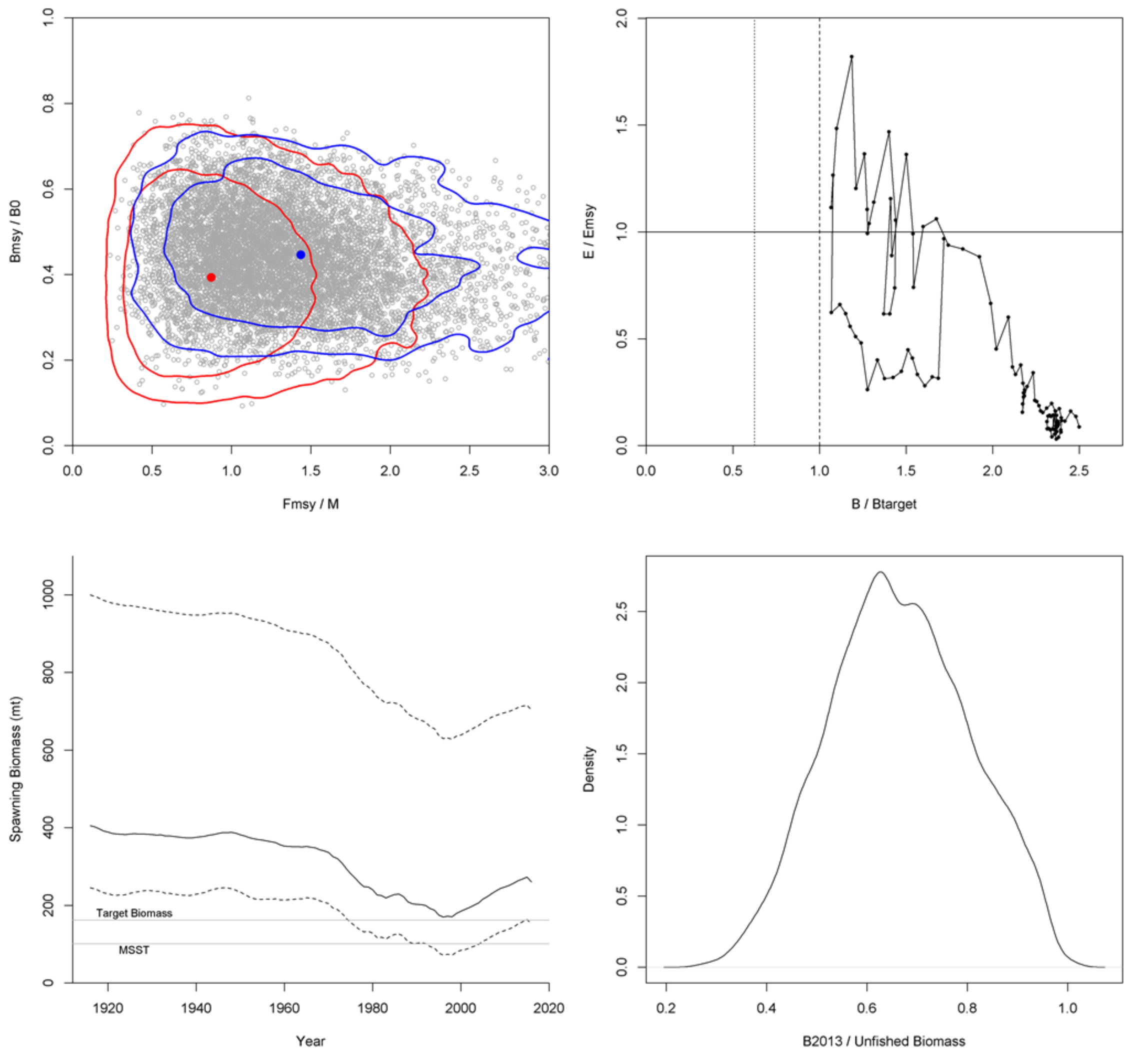

Figure 58. XDB-SRA results for China rockfish (south of 40° 10′ N lat.). <u>Upper left</u>: bivariate prior and posterior distributions for F_{MSY}/M and B_{MSY}/B_0. Red lines are 75% and 95% contours of the prior, blue lines are updated posterior contours. Grey circles are posterior draws, black circles represent rejected runs (biomass <0), large solid circles are centroids (medians) of the prior and posterior (red and blue, respectively). <u>Upper right</u>: trends in relative exploitation rate and relative biomass. Horizontal solid line is target exploitation rate (model-estimated), vertical lines (dashed and dotted) are target and threshold biomass values, $0.4B_0$ and $0.25B_0$, respectively. <u>Lower left</u>: Median, 5% and 95% quantiles of spawning biomass relative to target and minimum stock size threshold (MSST). <u>Lower right</u>: posterior density of current depletion (biomass in 2013 relative to unfished biomass).

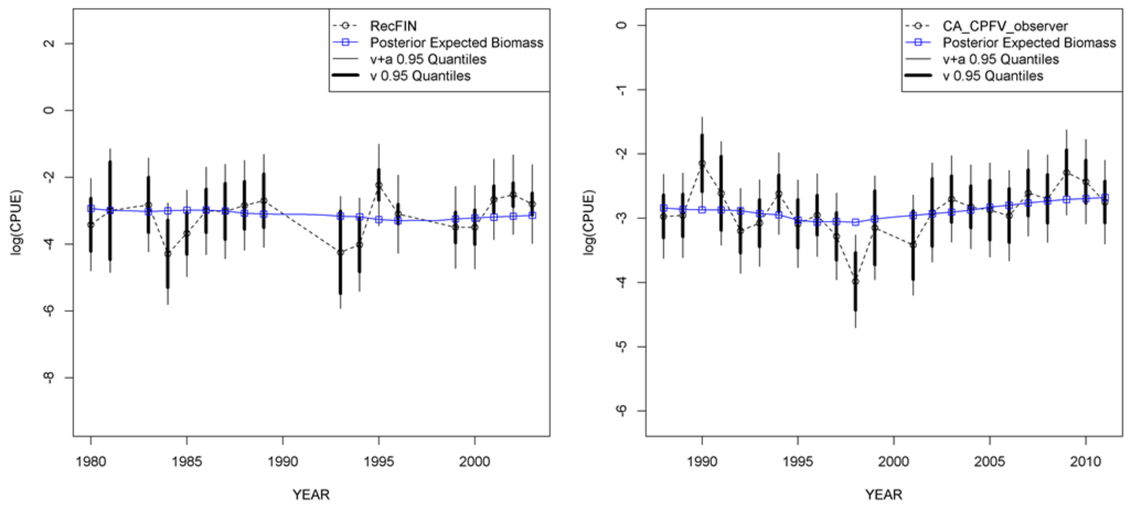

Figure 59. Fits of log-scale indices to XDB-SRA biomass trajectories for China rockfish (south of 40° 10′ N lat.). <u>Left</u>: Central California RecFIN dockside index. <u>Right</u>: Central California onboard CPFV observer index. Vertical lines are 95% intervals based on the input variance (thick portion) and combined variance (input plus additive) components (thin portion). Solid blue line is expected log-scale biomass, scaled for comparison.

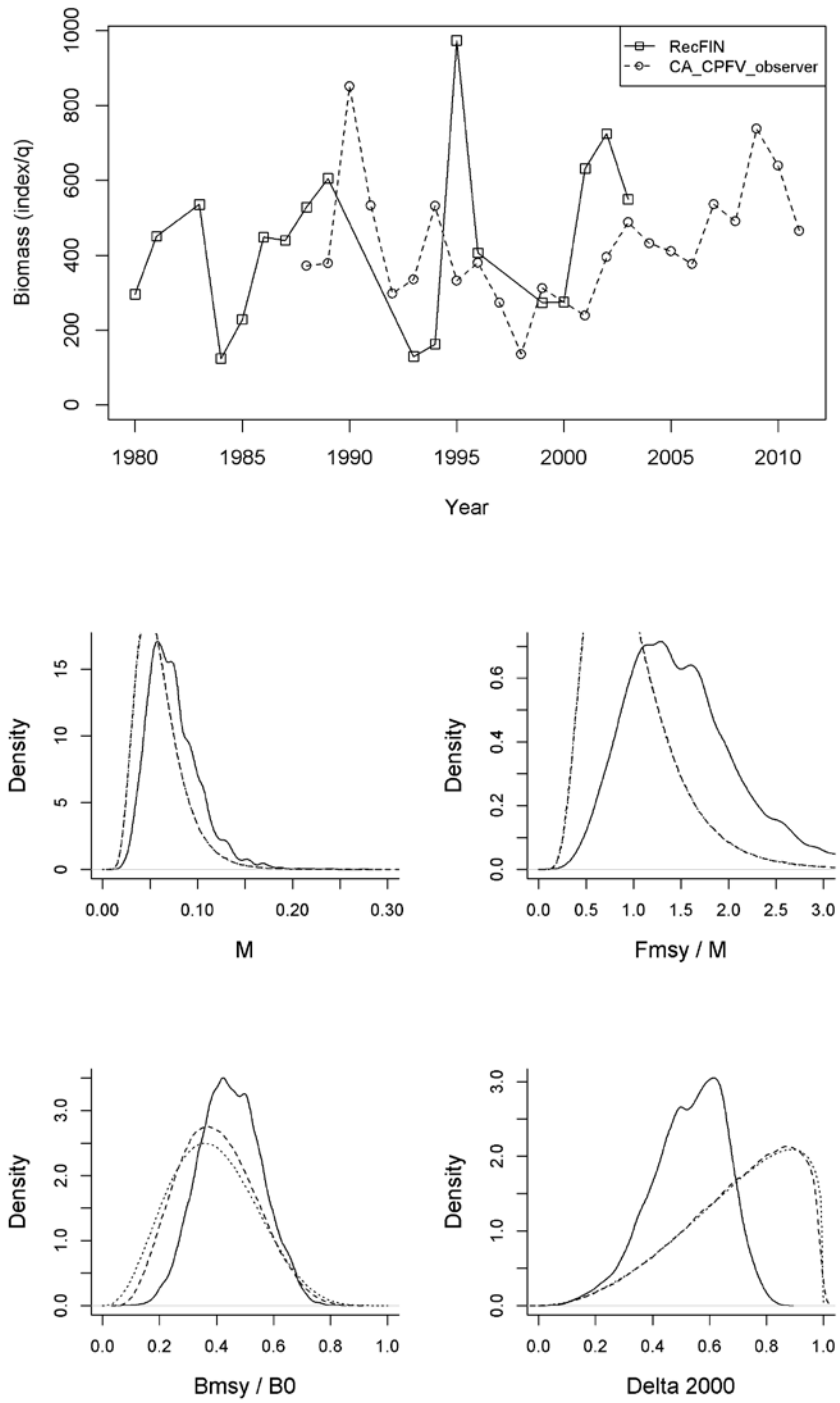

Figure 60. XDB-SRA results for China rockfish (south of 40° 10′ N lat.). <u>Top panel</u>: indices of abundance rescaled into biomass units (see previous figure for index descriptions). <u>Bottom panels</u>: prior (dotted), post-model pre-data (dashed), and posterior (solid) distributions of XDB-SRA parameters.

8.2.2.2 Northern China Rockfish (N of 40° 10′ N lat.).

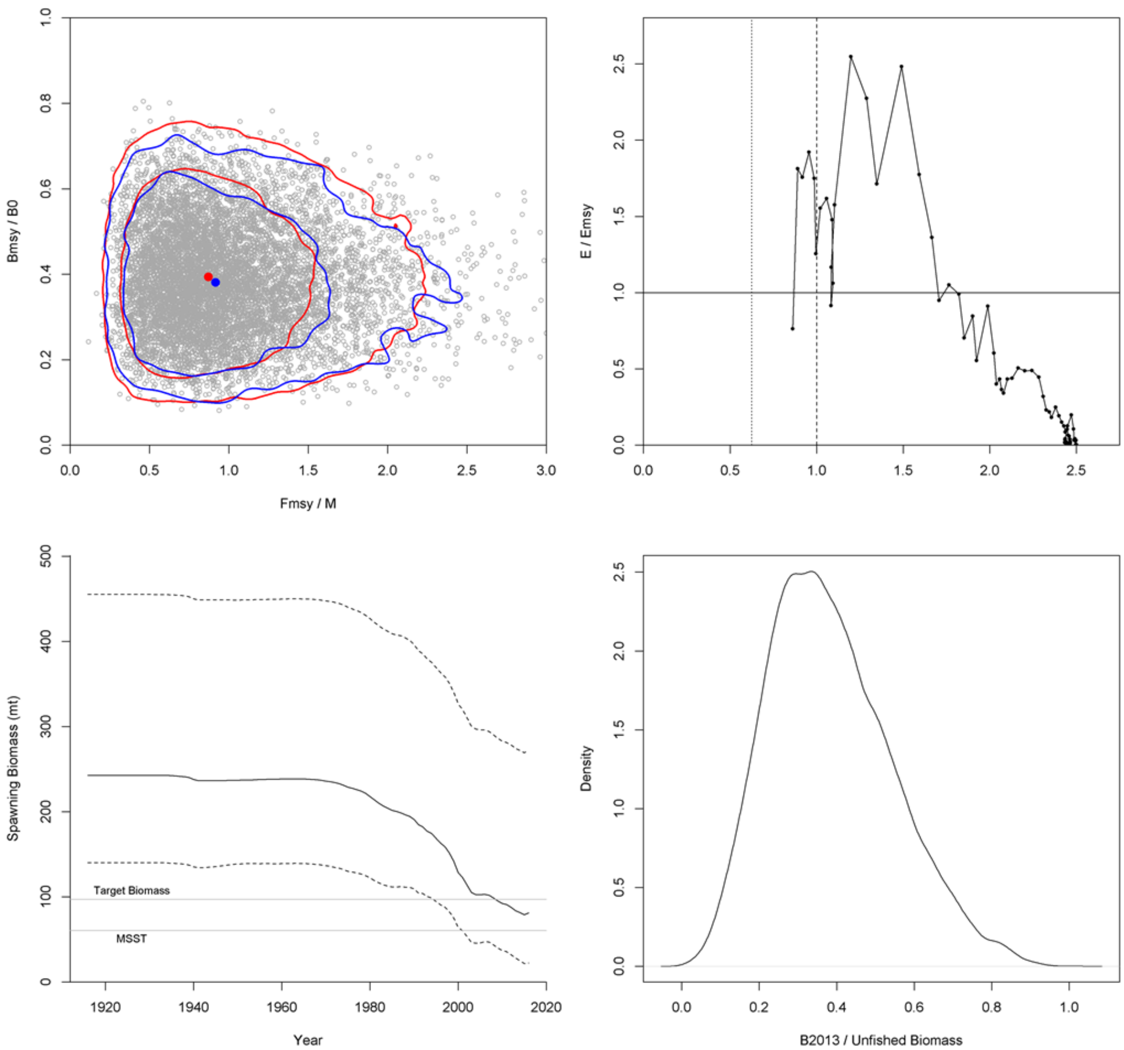

Figure 61. XDB-SRA results for China rockfish (north of 40° 10′ N lat.). <u>Upper left</u>: bivariate prior and posterior distributions for F_{MSY}/M and B_{MSY}/B_0. Red lines are 75% and 95% contours of the prior, blue lines are updated posterior contours. Grey circles are posterior draws, black circles represent rejected runs (biomass <0), large solid circles are centroids (medians) of the prior and posterior (red and blue, respectively). <u>Upper right</u>: trends in relative exploitation rate and relative biomass. Horizontal solid line is target exploitation rate (model-estimated), vertical lines (dashed and dotted) are target and threshold biomass values, $0.4B_0$ and $0.25B_0$, respectively. <u>Lower left</u>: Median, 5% and 95% quantiles of spawning biomass relative to target and minimum stock size threshold (MSST). <u>Lower right</u>: posterior density of current depletion (biomass in 2013 relative to unfished biomass).

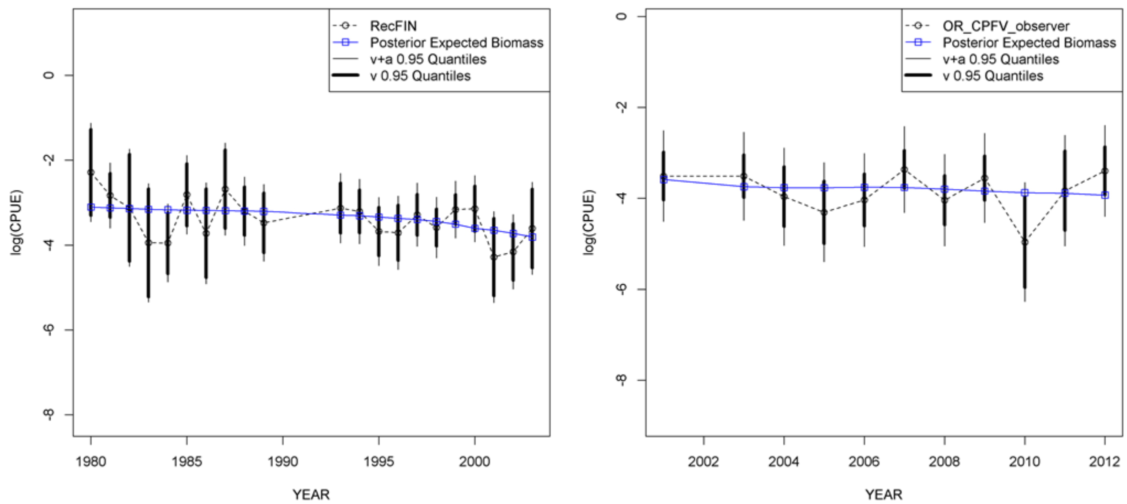

Figure 62. Fits of log-scale indices to XDB-SRA biomass trajectories for China rockfish (north of 40° 10′ N lat.). Left: No. CA / OR RecFIN dockside index. Right: Oregon onboard CPFV observer index. Vertical lines are 95% intervals based on the input variance (thick portion) and combined variance (input plus additive) components (thin portion). Solid blue line is expected log-scale biomass, scaled for comparison.

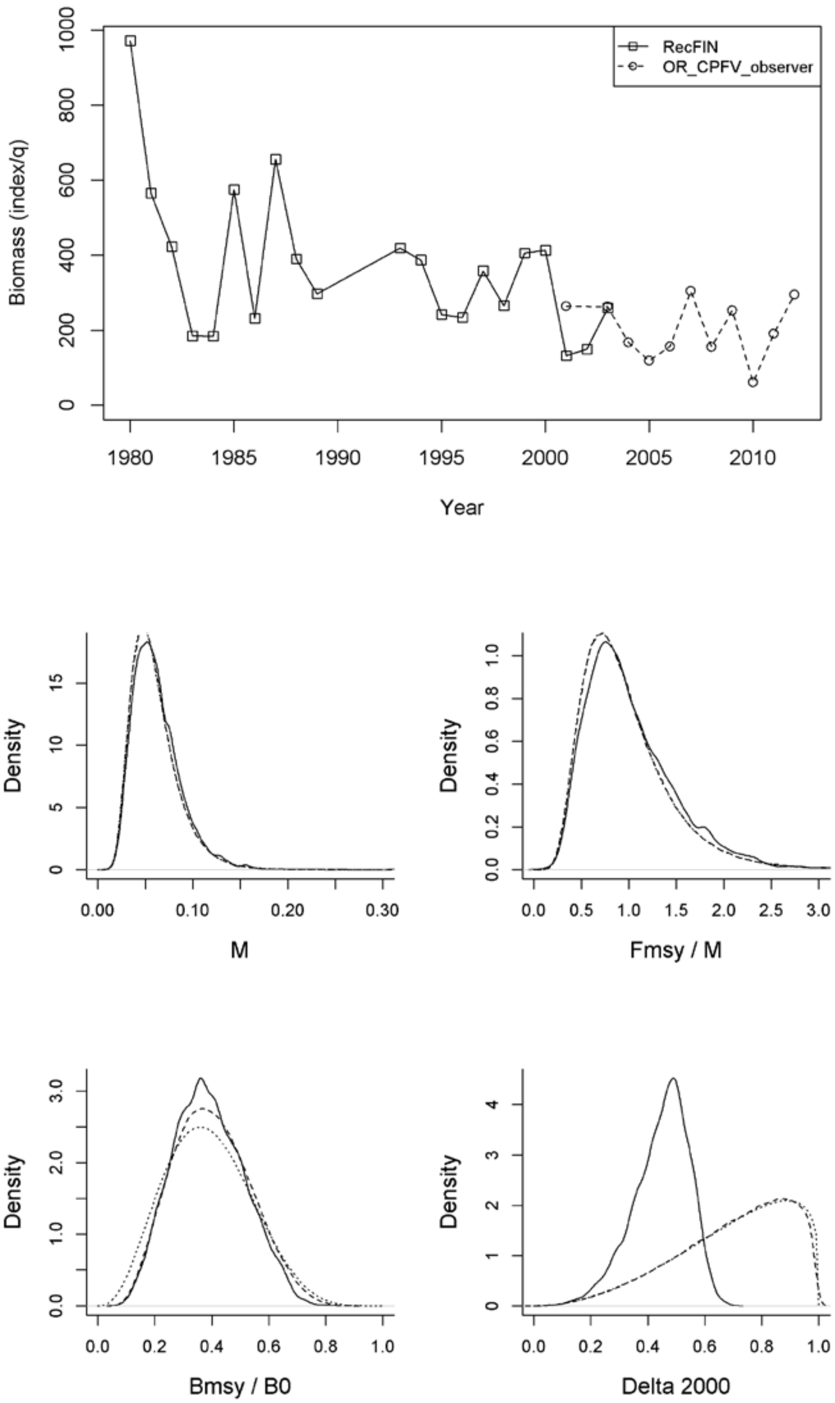

Figure 63. XDB-SRA results for China rockfish (north of 40° 10′ N lat.). Top panel: indices of abundance rescaled into biomass units (see previous figure for index descriptions). Bottom panels: prior (dotted), post-model pre-data (dashed), and posterior (solid) distributions of XDB-SRA parameters.

8.2.3 Copper rockfish

8.2.3.1 Copper Rockfish North of Point Conception (34° 27′ N lat.)

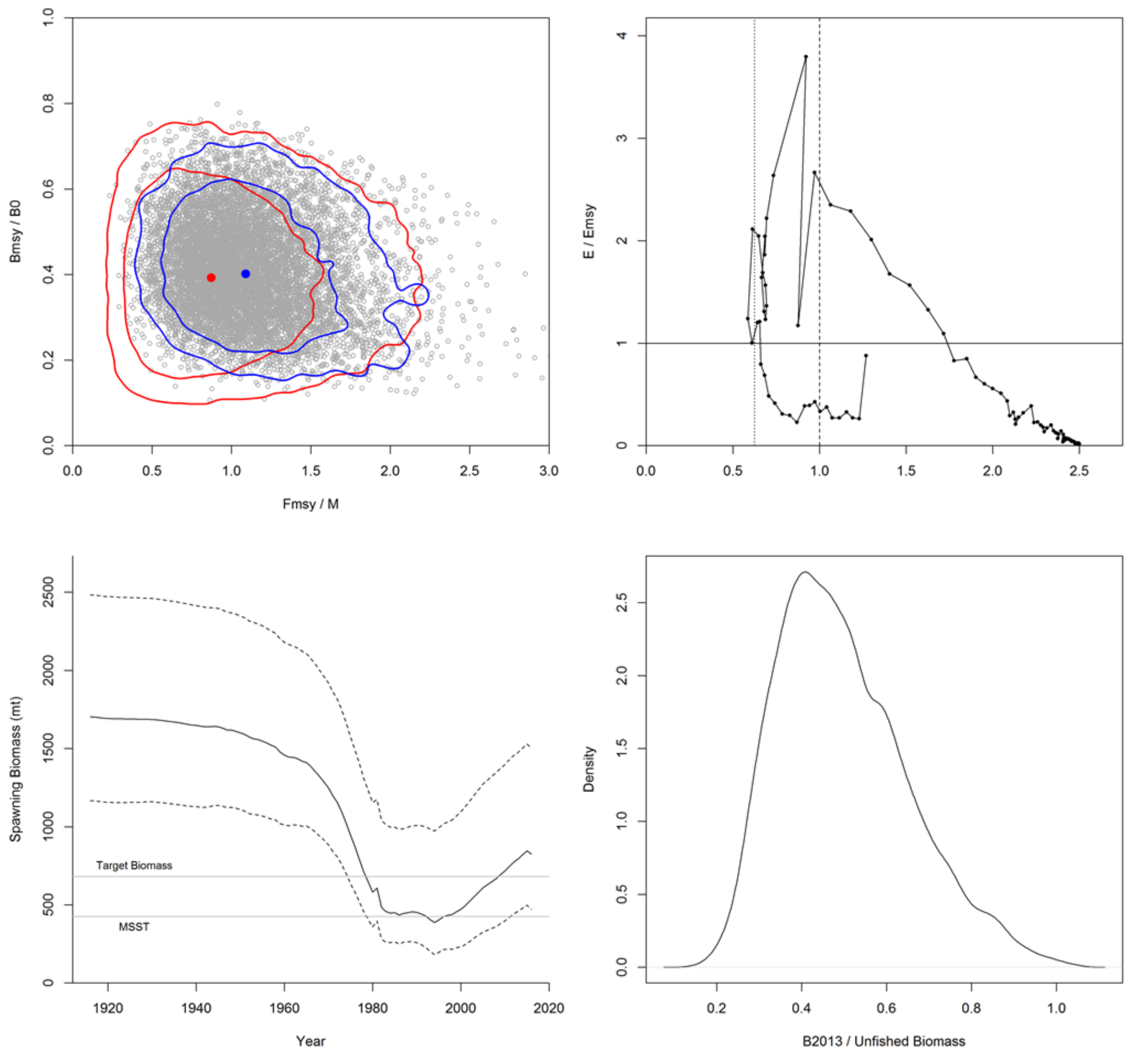

Figure 64. XDB-SRA results for copper rockfish (north of 34° 27′ N lat.). Upper left: bivariate prior and posterior distributions for F_{MSY}/M and B_{MSY}/B_0. Red lines are 75% and 95% contours of the prior, blue lines are updated posterior contours. Grey circles are posterior draws, black circles represent rejected runs (biomass <0), large solid circles are centroids (medians) of the prior and posterior (red and blue, respectively). Upper right: trends in relative exploitation rate and relative biomass. Horizontal solid line is target exploitation rate (model-estimated), vertical lines (dashed and dotted) are target and threshold biomass values, $0.4B_0$ and $0.25B_0$, respectively. Lower left: Median, 5% and 95% quantiles of spawning biomass relative to target and minimum stock size threshold (MSST). Lower right: posterior density of current depletion (biomass in 2013 relative to unfished biomass).

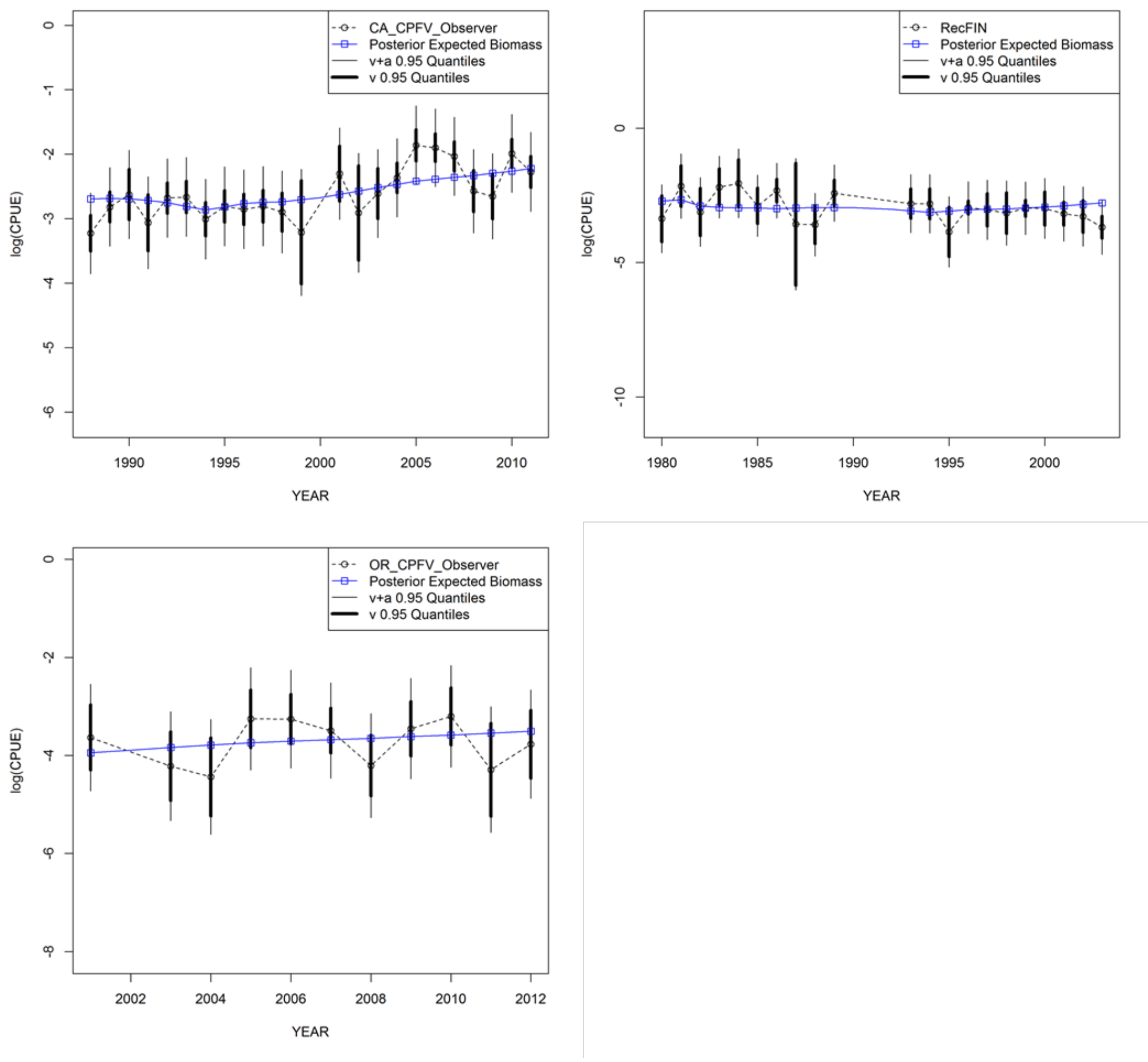

Figure 65. Fits of log-scale indices to XDB-SRA biomass trajectories for copper rockfish (north of 34° 27′ N lat.). <u>Upper left</u>: Central California onboard CPFV observer index. <u>Upper right</u>: Central/Northern California and Oregon RecFIN dockside index. <u>Lower left</u>: Oregon onboard CPFV observer index. Vertical lines are 95% intervals based on the input variance (thick portion) and combined variance (input plus additive) components (thin portion). Solid blue line is expected log-scale biomass, scaled for comparison.

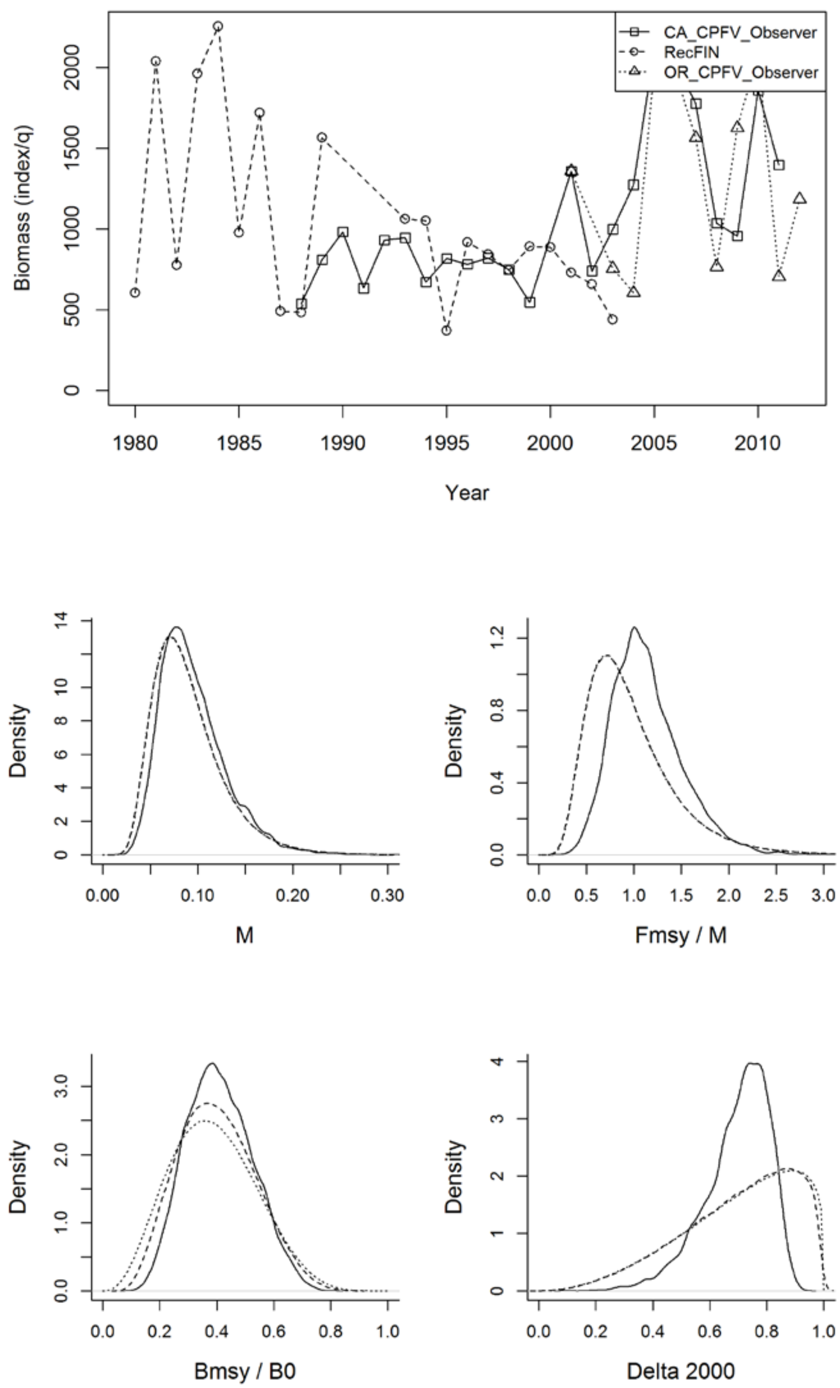

Figure 66. XDB-SRA results for copper rockfish (north of 34° 27′ N lat.). Top panel: indices of abundance rescaled into biomass units (see previous figure for index descriptions). Bottom panels: prior (dotted), post-model pre-data (dashed), and posterior (solid) distributions of XDB-SRA parameters.

8.2.3.2 Southern Copper Rockfish (S. of 34° 27′ N lat.).

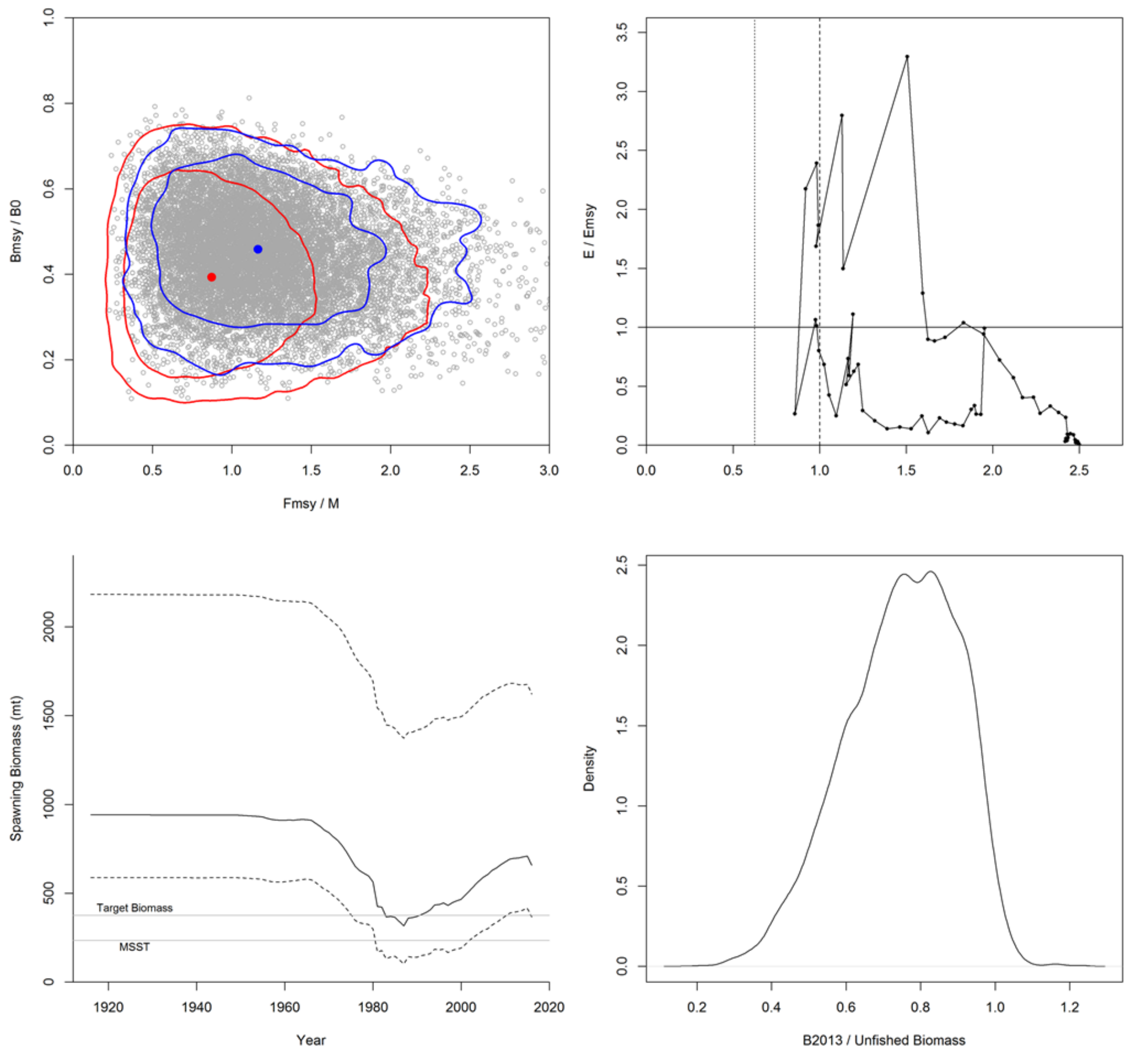

Figure 67. XDB-SRA results for copper rockfish (south of 34° 27′ N lat.). <u>Upper left</u>: bivariate prior and posterior distributions for F_{MSY}/M and B_{MSY}/B_0. Red lines are 75% and 95% contours of the prior, blue lines are updated posterior contours. Grey circles are posterior draws, black circles represent rejected runs (biomass <0), large solid circles are centroids (medians) of the prior and posterior (red and blue, respectively). <u>Upper right</u>: trends in relative exploitation rate and relative biomass. Horizontal solid line is target exploitation rate (model-estimated), vertical lines (dashed and dotted) are target and threshold biomass values, $0.4B_0$ and $0.25B_0$, respectively. <u>Lower left</u>: Median, 5% and 95% quantiles of spawning biomass relative to target and minimum stock size threshold (MSST). <u>Lower right</u>: posterior density of current depletion (biomass in 2013 relative to unfished biomass).

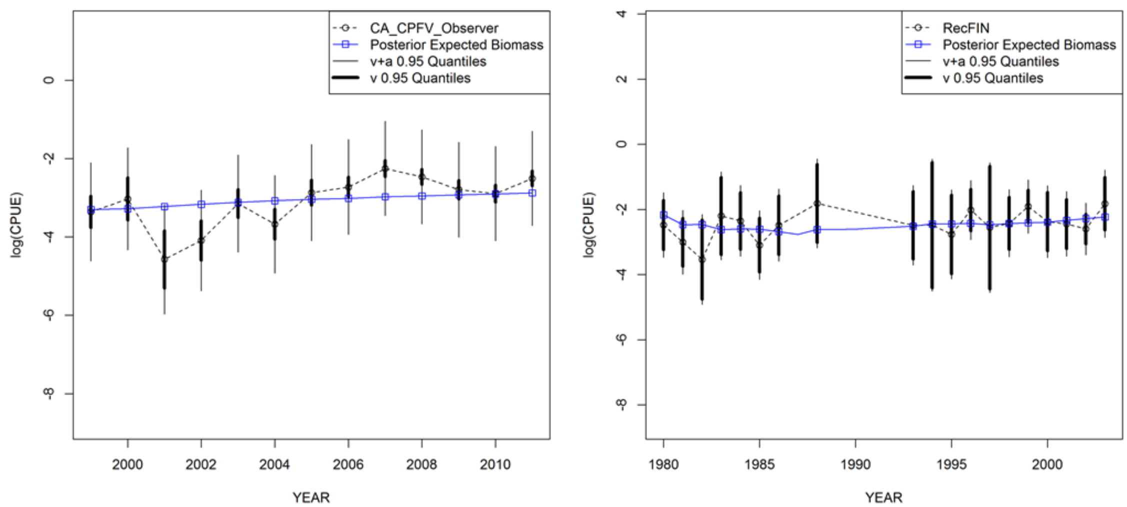

Figure 68. Fits of log-scale indices to XDB-SRA biomass trajectories for copper rockfish (south of 34° 27′ N lat.). <u>Index 1</u>: Southern California onboard CPFV observer index. <u>Index 2</u>: Southern California RecFIN dockside index. Vertical lines are 95% intervals based on the input variance (thick portion) and combined variance (input plus additive) components (thin portion). Solid blue line is expected log-scale biomass.

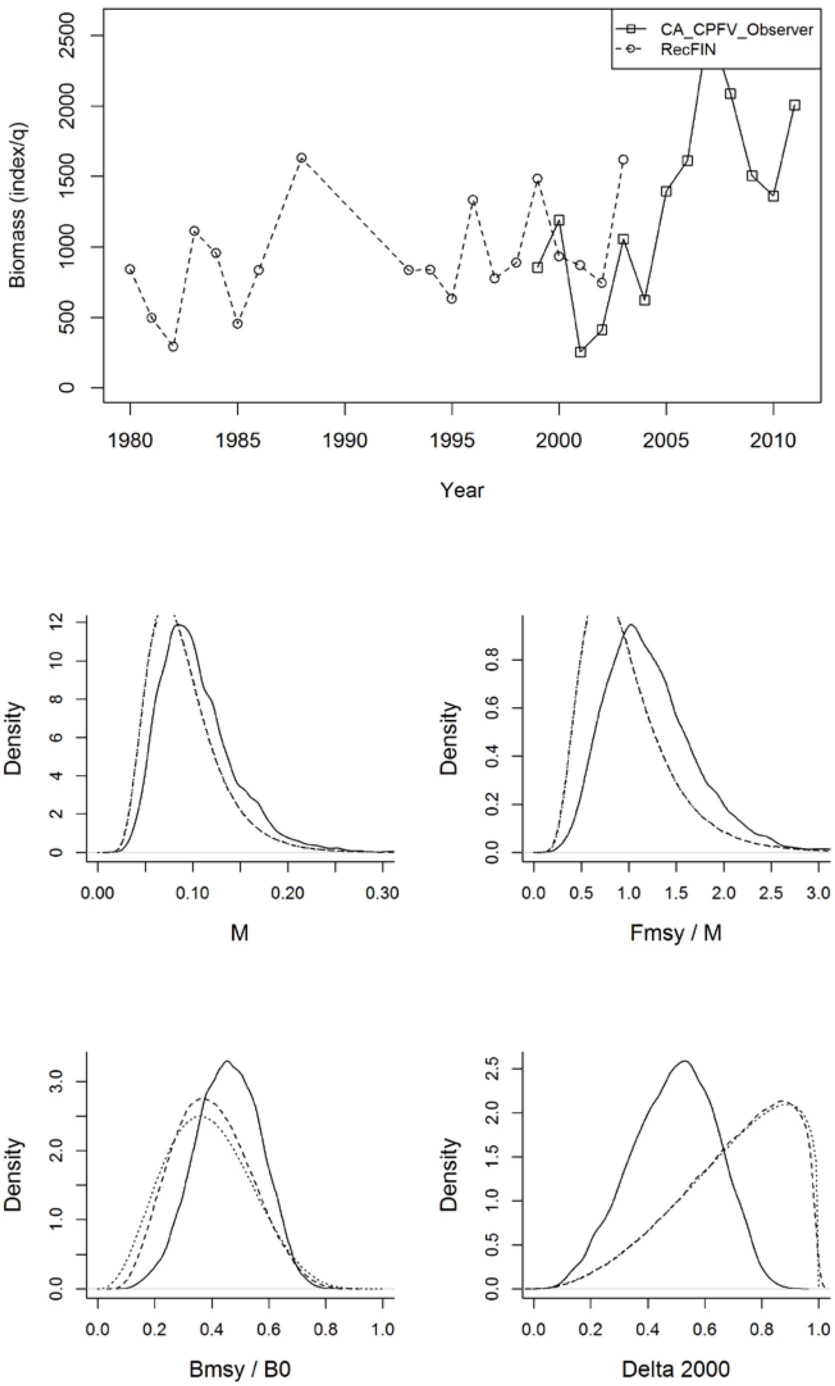

Figure 69. XDB-SRA results for copper rockfish (south of 34° 27′ N lat.). <u>Top panel</u>: indices of abundance rescaled into biomass units (see previous figure for index descriptions). <u>Bottom panels</u>: prior (dotted), post-model pre-data (dashed), and posterior (solid) distributions of XDB-SRA parameters.

8.2.4 Sharpchin rockfish

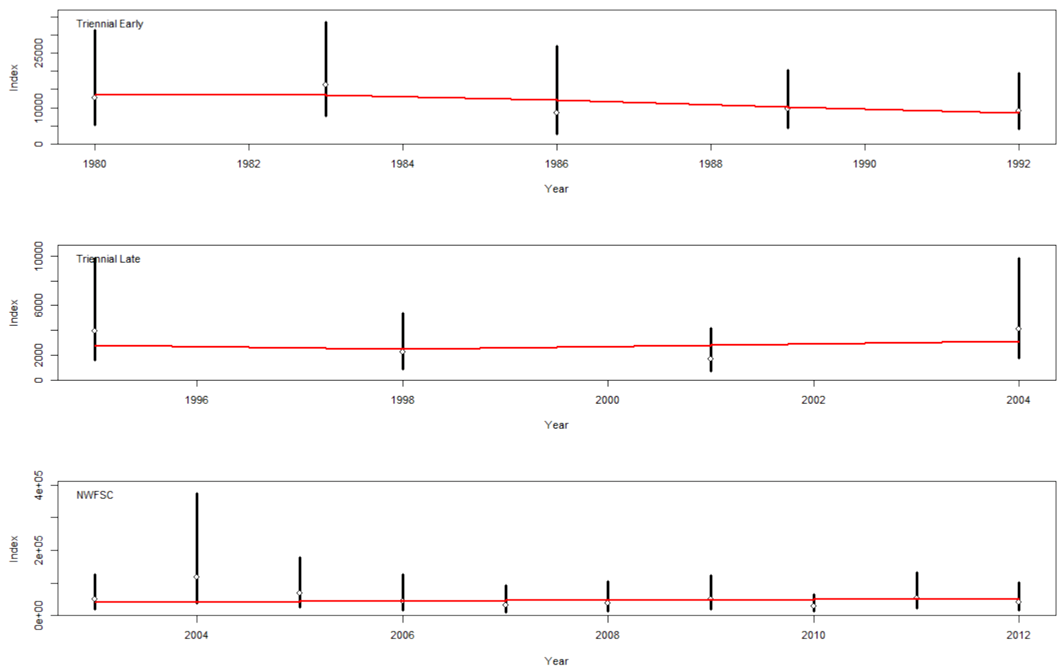

Figure 70. Fits to the three fishery-independent surveys from the exSSS model for sharpchin rockfish. Thick lines are inputted variance; thin lines are estimated added variance.

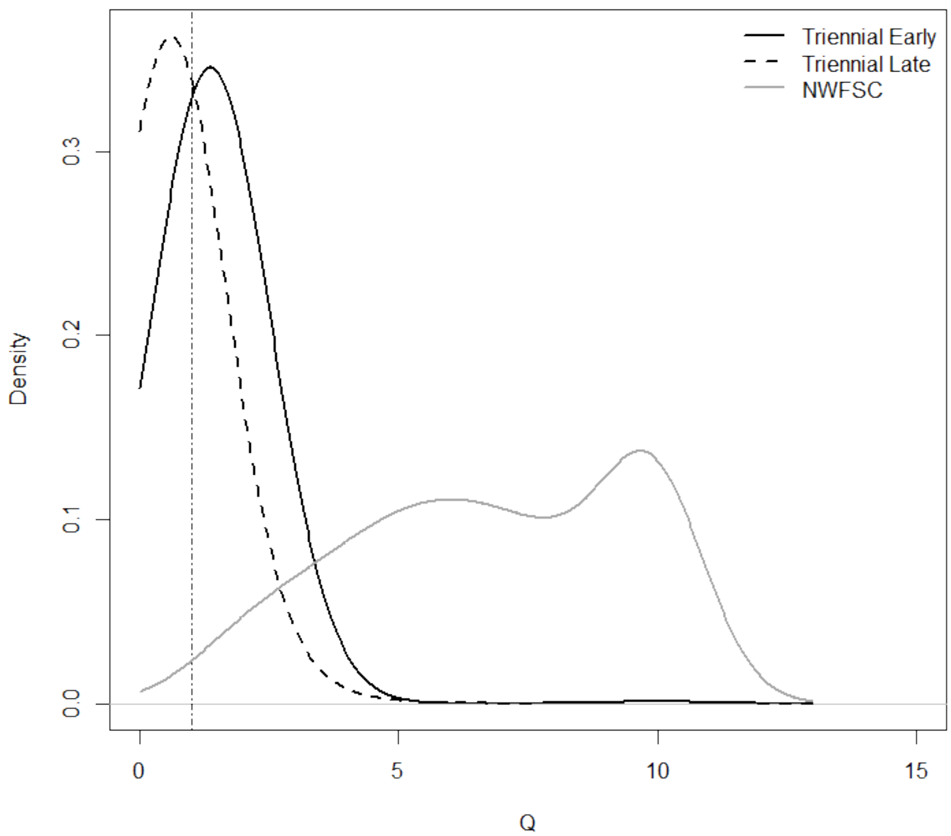

Figure 71. Posterior distribution of the catchability parameters (q) for each index fit in the exSSS AIS sharpchin rockfish assessment. Vertical line indicate q=1.

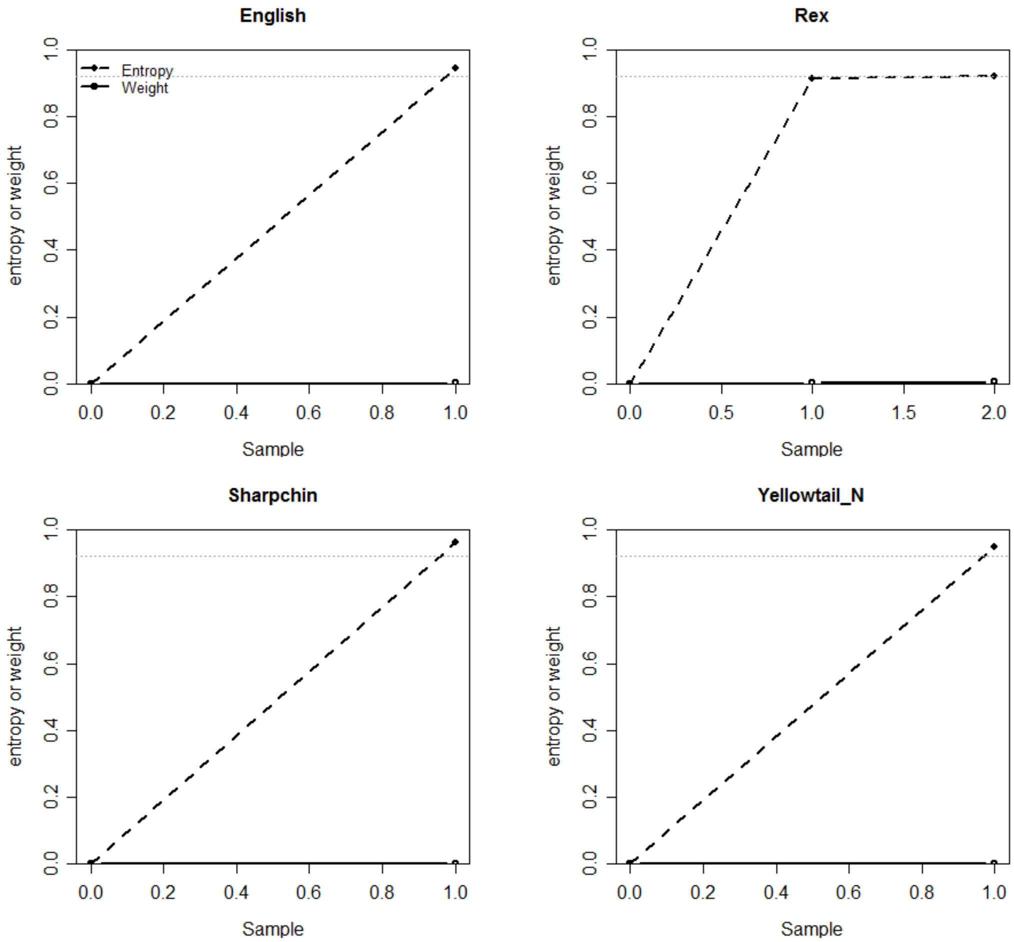

Figure 72. Entropy and model weight values used to determine model convergence in the exSSS AIS models for 4 stocks. Dotted horizontal line is the threshold entropy value of 0.92 indicating convergence.

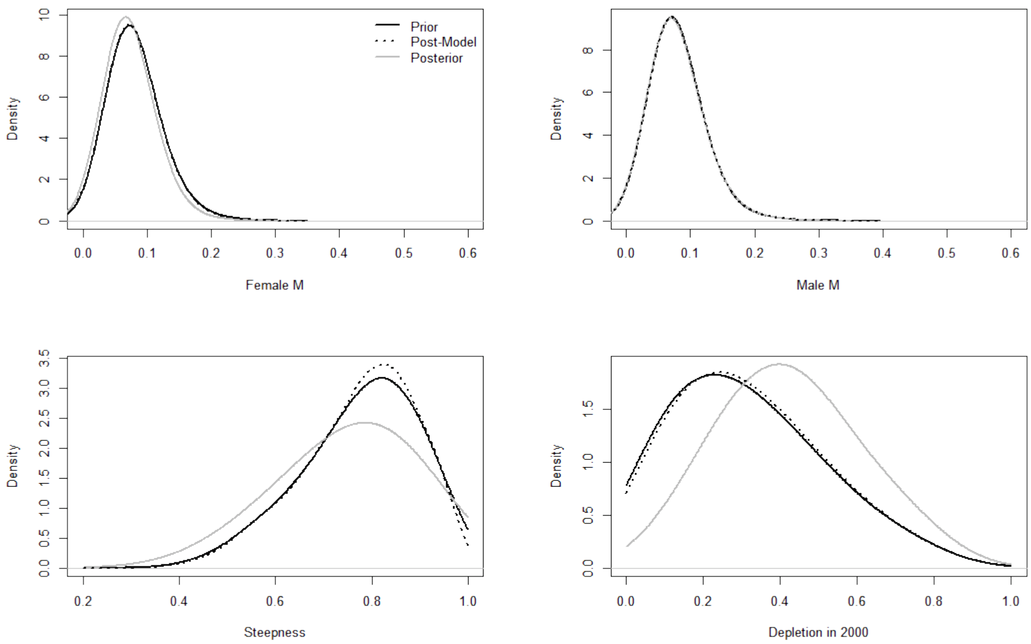

Figure 73. Prior and posterior distributions for each input parameter of the exSSS AIS uncertainty estimation for sharpchin rockfish.

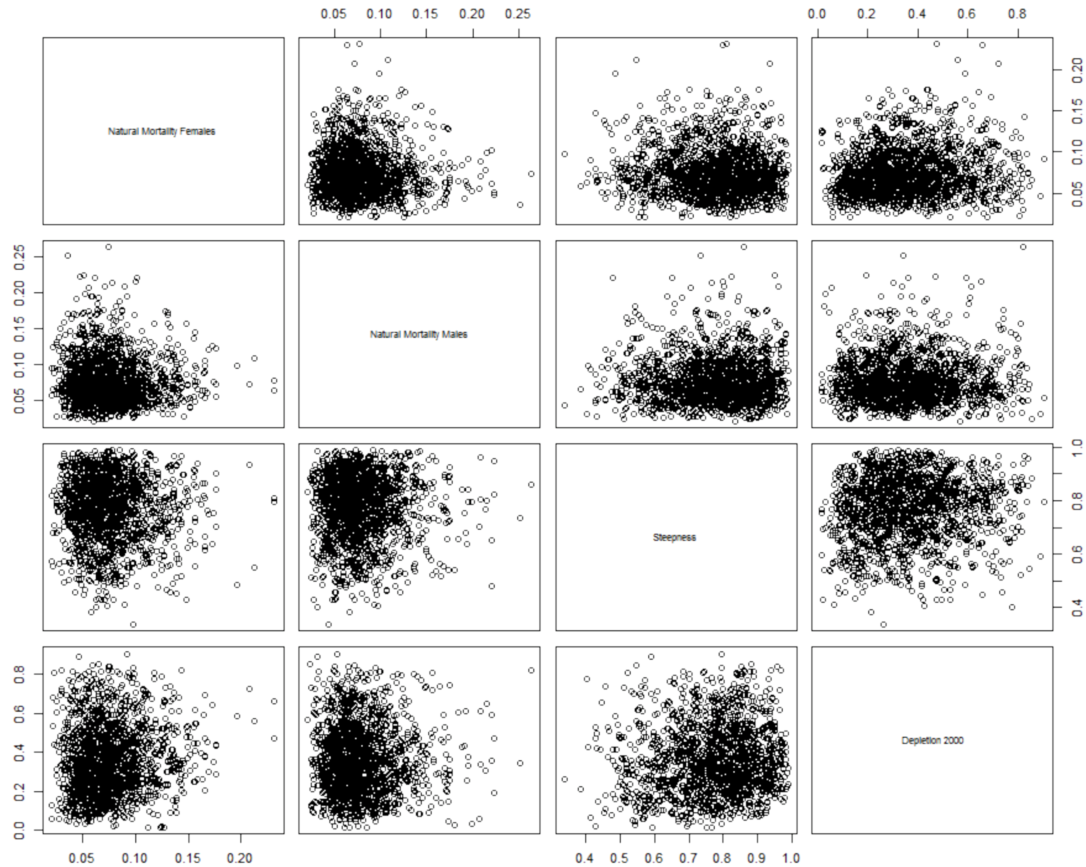

Figure 74. Pairs plots for each parameter in the exSSS AIS treatment of uncertainty for sharpchin rockfish.

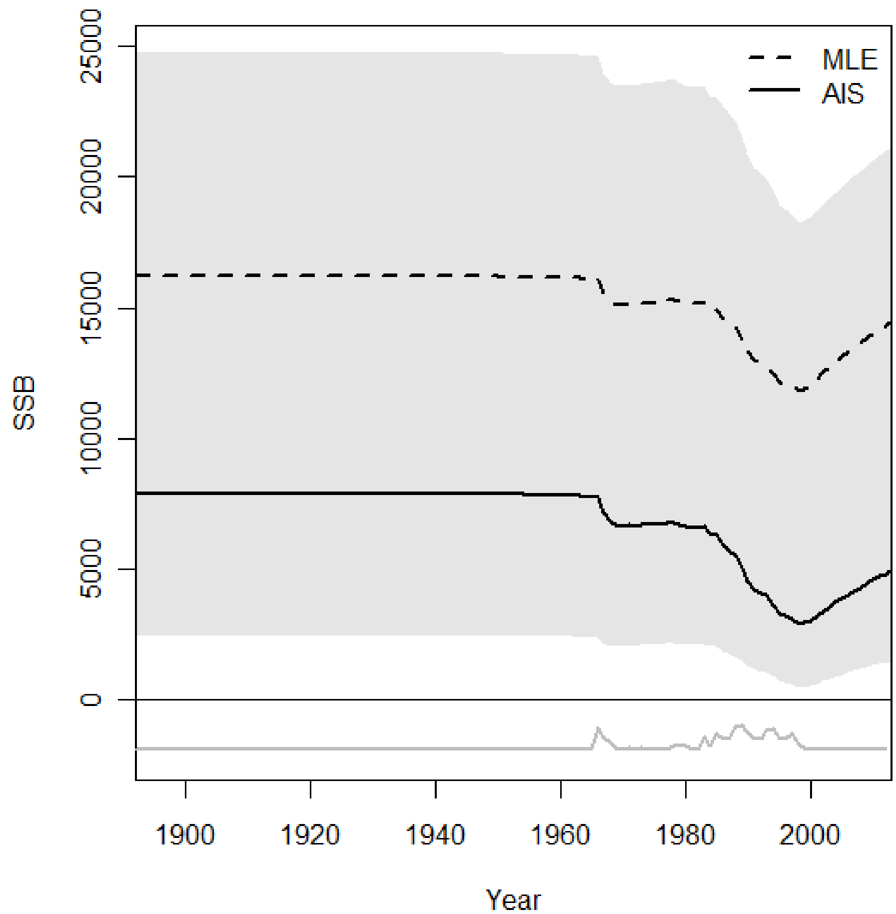

Figure 75. Time series of spawning biomass from the exSSS MLE (broken line) and AIS (solid line with gray uncertainty bars) for sharpchin rockfish. Catch history is provided below the 0 line.

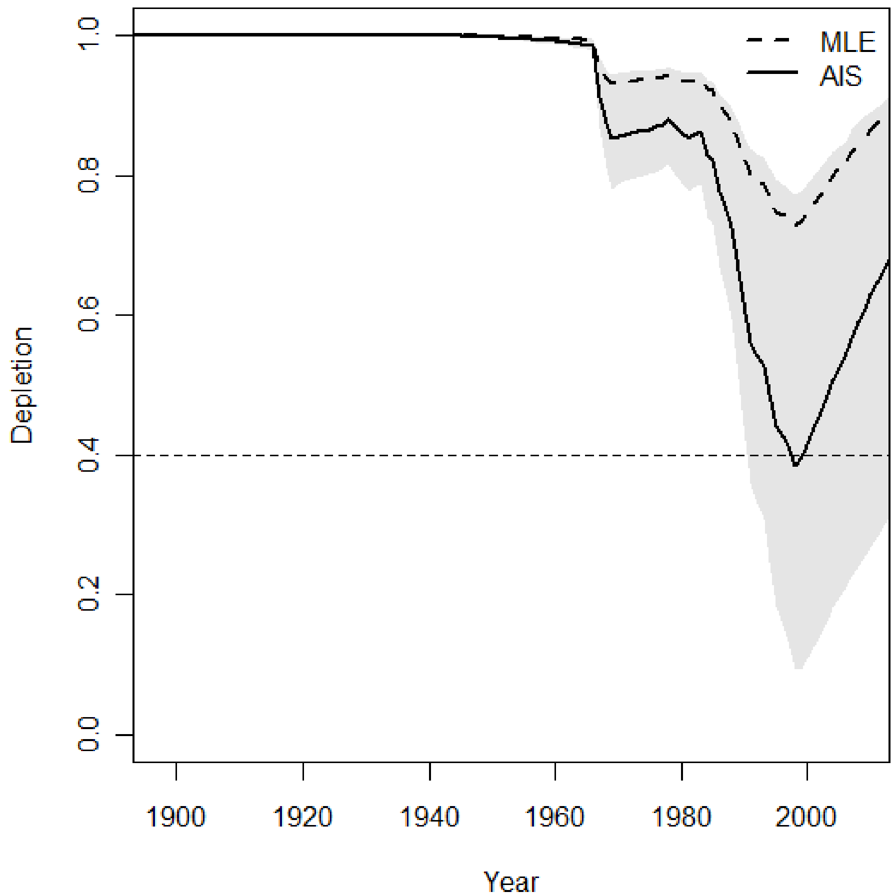

Figure 76. Time series of stock status (depletion) from the exSSS MLE (broken line) and AIS (solid line with gray uncertainty bars) for sharpchin rockfish.

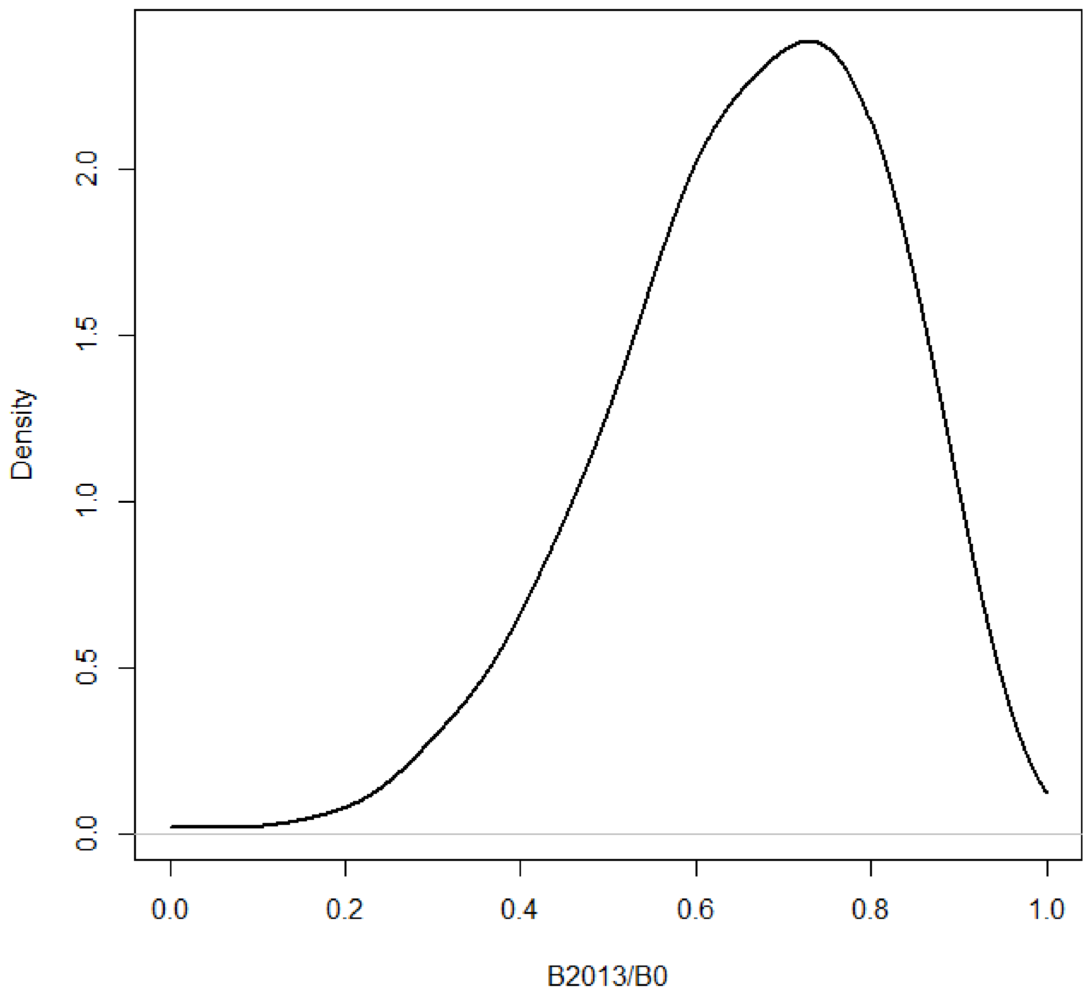

Figure 77. Stock status posterior distribution from the exSSS AIS model for sharpchin rockfish.

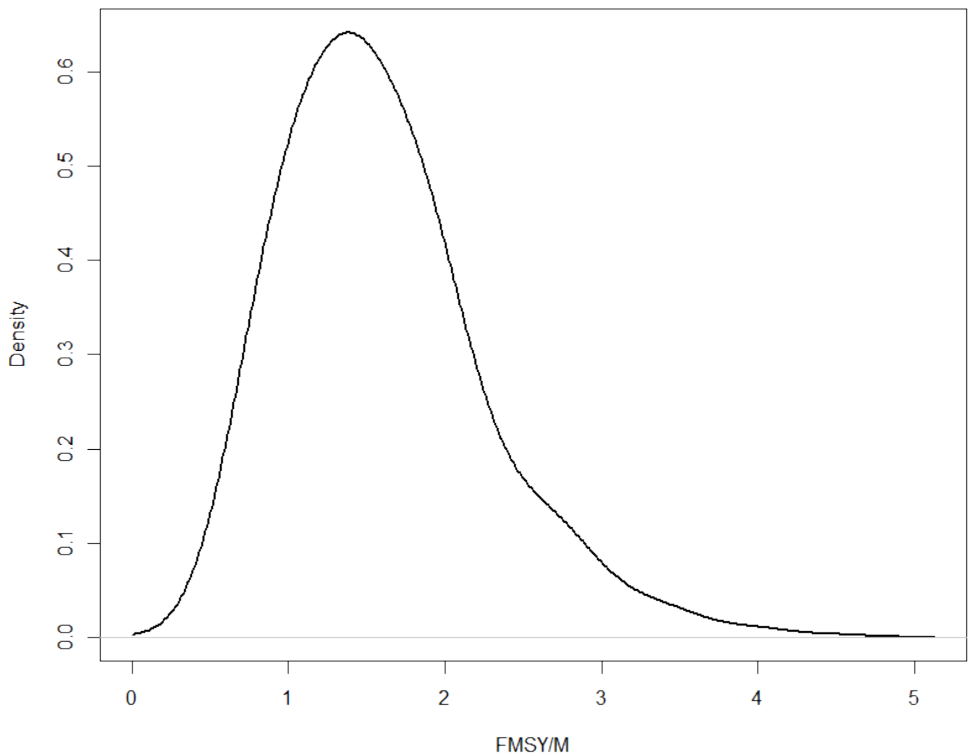

Figure 78. Posterior distribution of F_{MSY}/M from the exSSS AIS model for sharpchin rockfish.

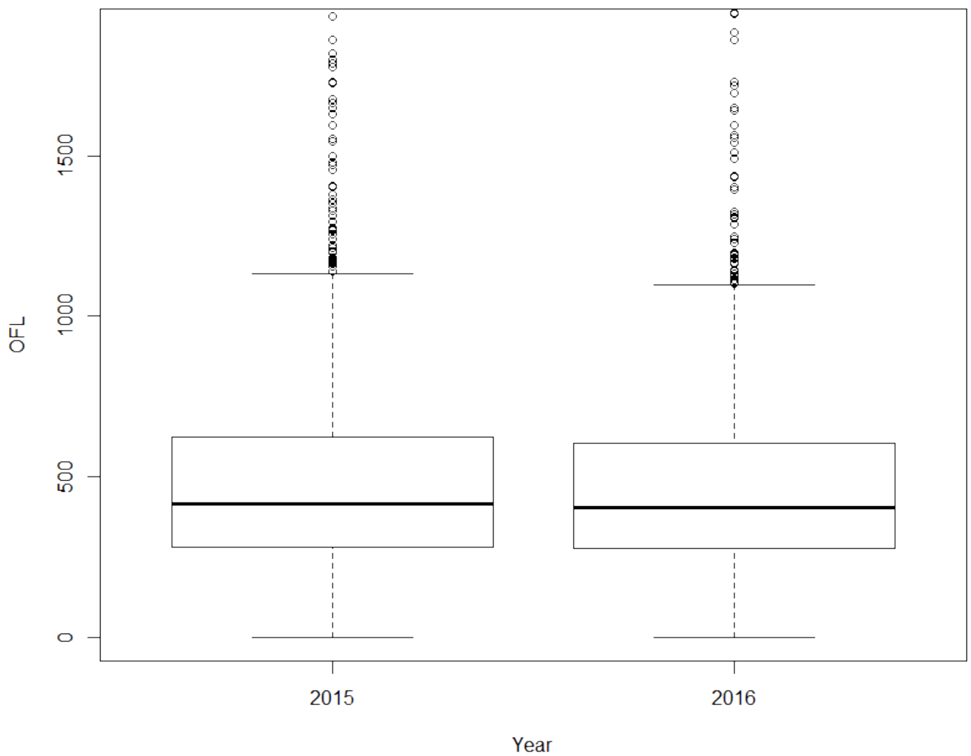

Figure 79. Posterior distribution of OFLs **from the exSSS AIS model for sharpchin rockfish.**

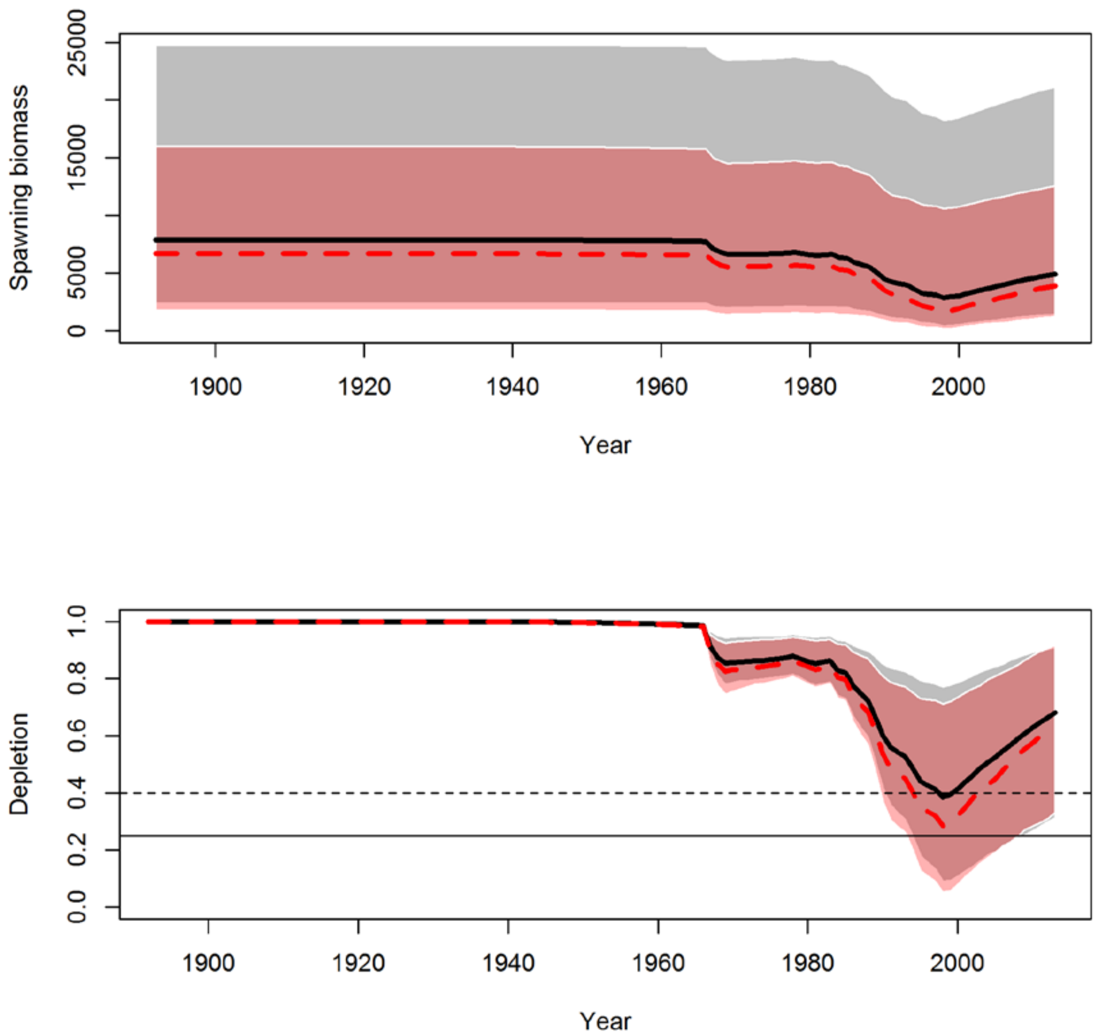

Figure 80 . Comparison of the exSSS AIS (black line, gray shaded 95% CI) and catch-only (SSS; red broken line; pink shaded 95% CI) estimates of spawning biomass (upper panel) and stock status (lower panel) for sharpchin rockfish. Darker red shaded area is the overlap of the top models.

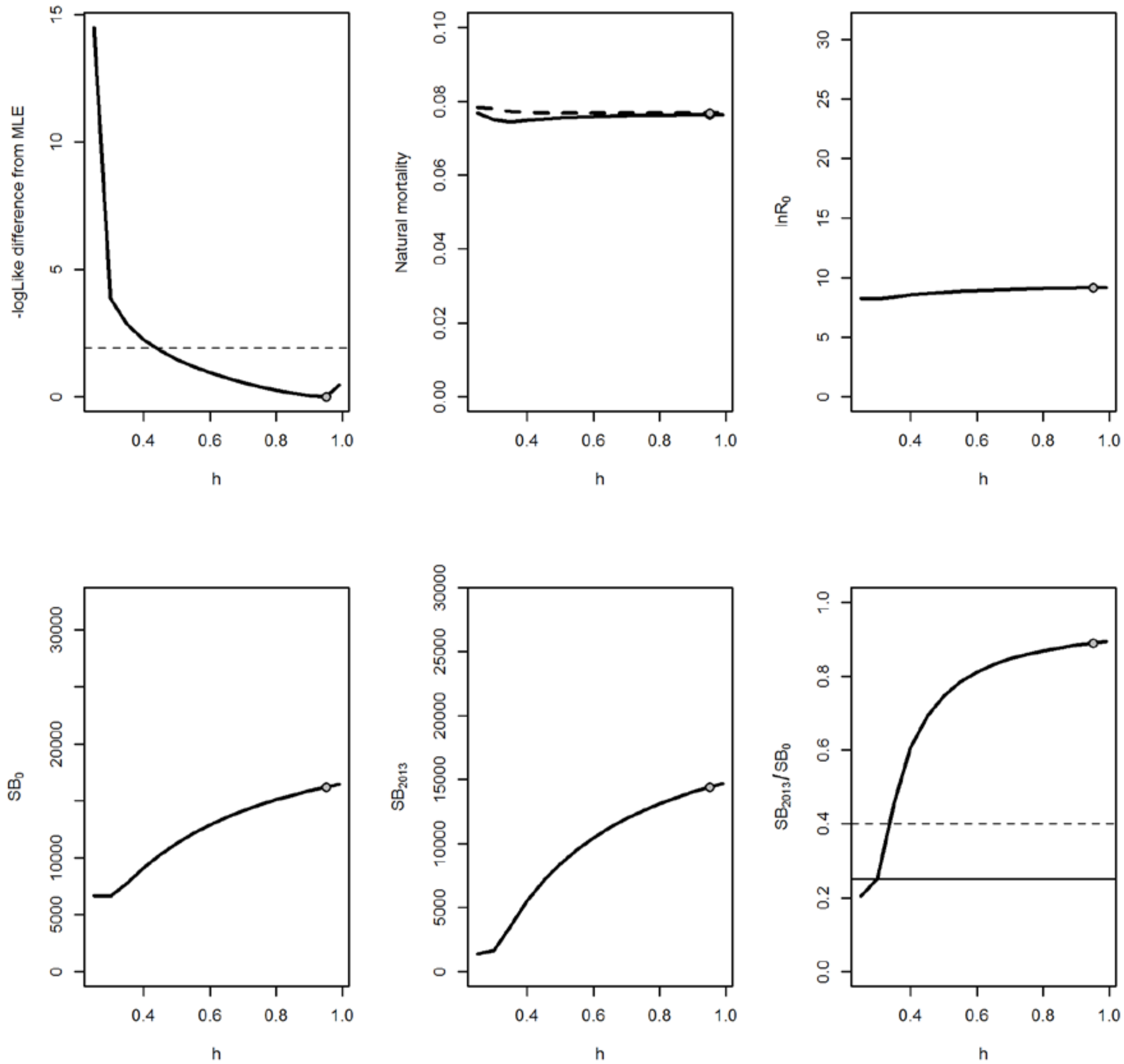

Figure 81. Likelihood profile for steepness (h; top left panel) and sensitivity to h of estimated (top center and right panels) and derived assessment outputs (bottom panels) for sharpchin rockfish using exSSS. The MLE is indicated by the circle. Top left panel: broken line is 95% interval; Top middle panel: solid and broken lines are the female and male *M* values; Bottom right panel: Solid and broken line are the target and limit biomass reference points.

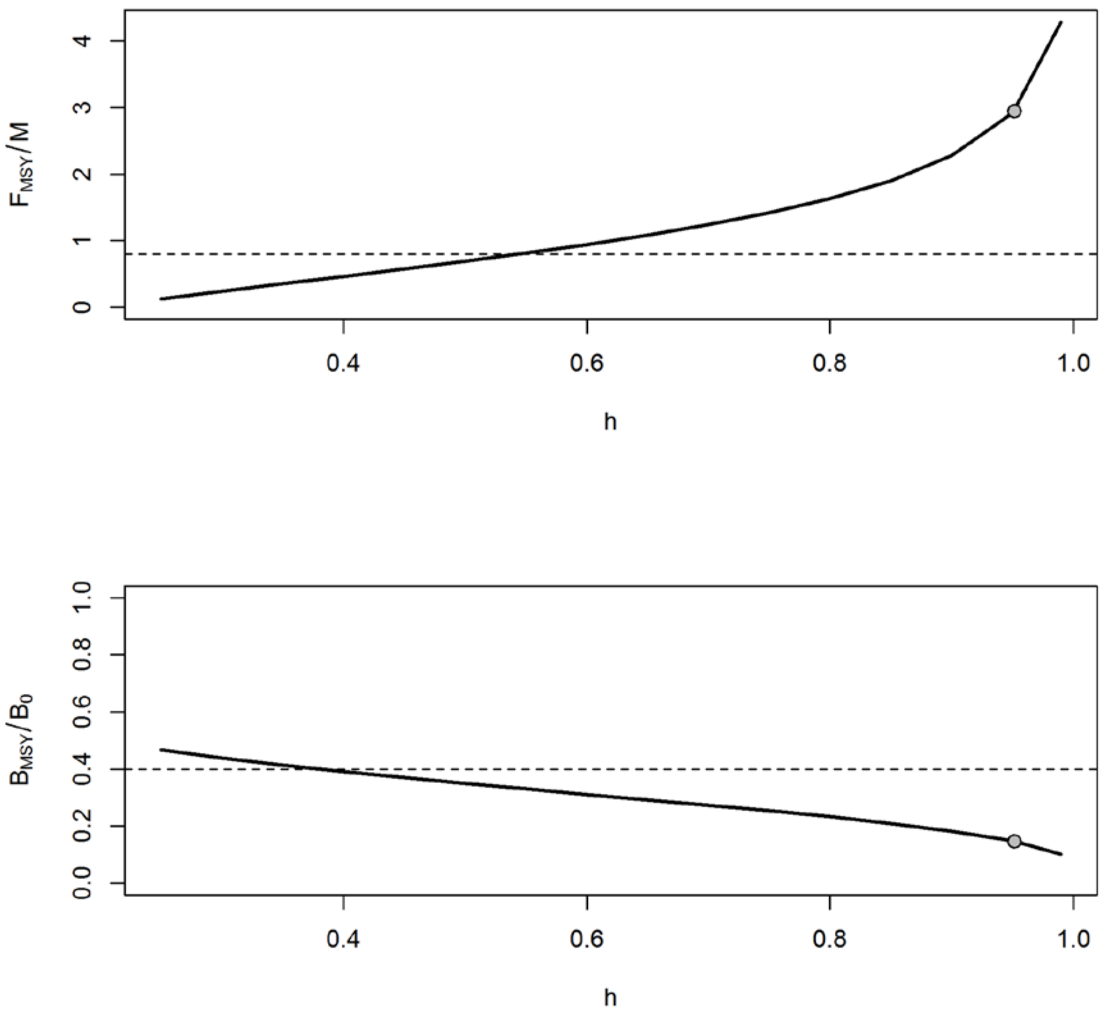

Figure 82. Steepness profile relative to XDB-SRA productivity parameters F_{MSY}/M (top panel) and B_{MSY}/B_0 (bottom panel) for sharpchin rockfish. Circle indicates exSSS MLE estimate. Broken line is the prior mean used in XDB-SRA.

8.2.5 Yellowtail rockfish (North of 40° 10’ N lat.)

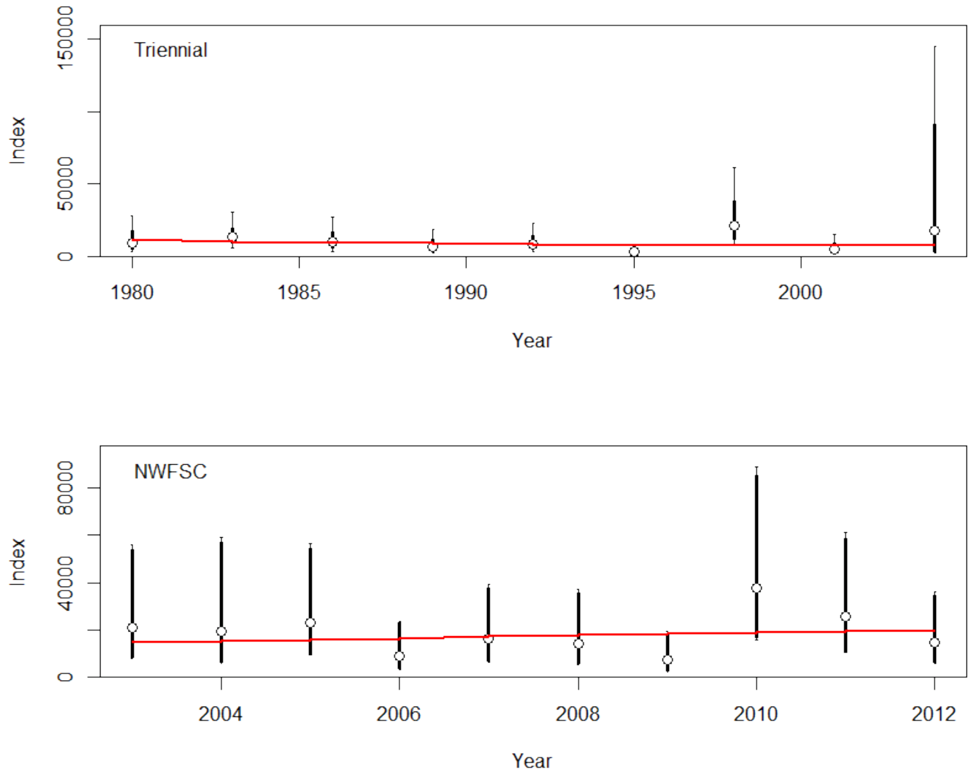

Figure 83. Fits to the three fishery-independent surveys from the exSSS AIS model for yellowtail rockfish (North of 40° 10’ N lat.). Thick lines are inputted variance; thin lines are estimated added variance.

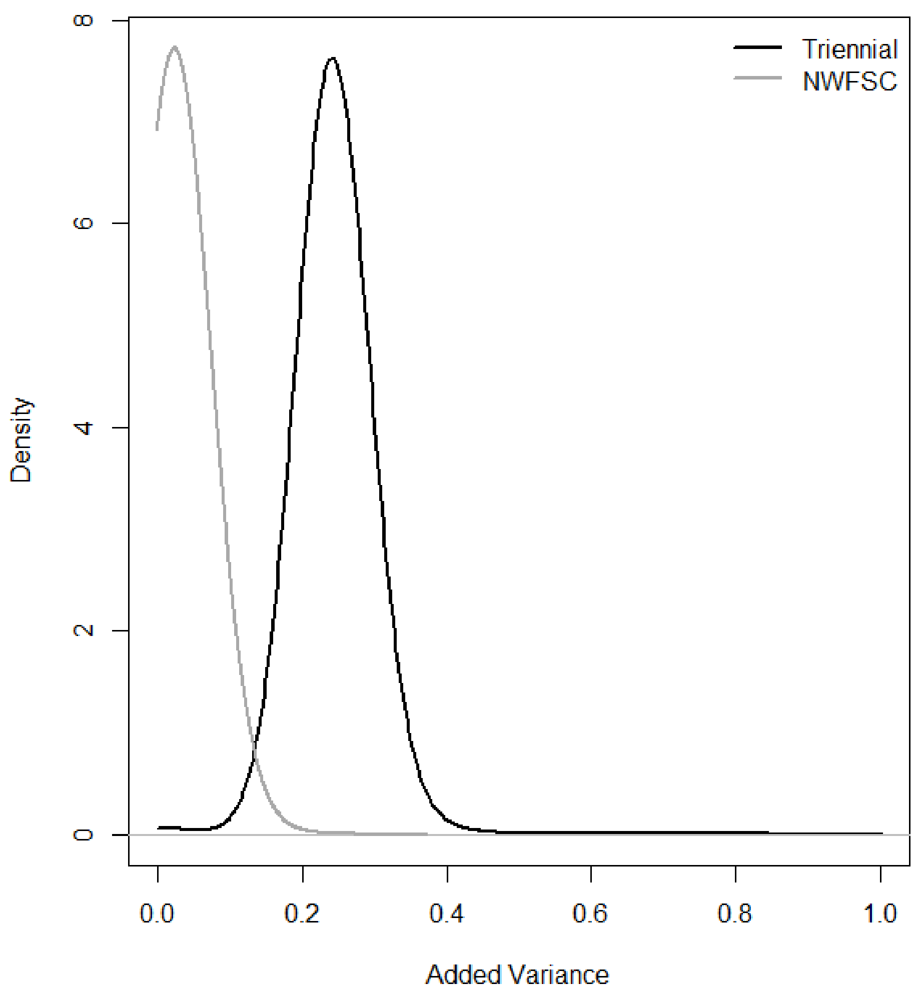

Figure 84. Posterior distribution of the added variance for each index fit in the exSSS AIS yellowtail rockfish (North of 40° 10' N lat.) assessment.

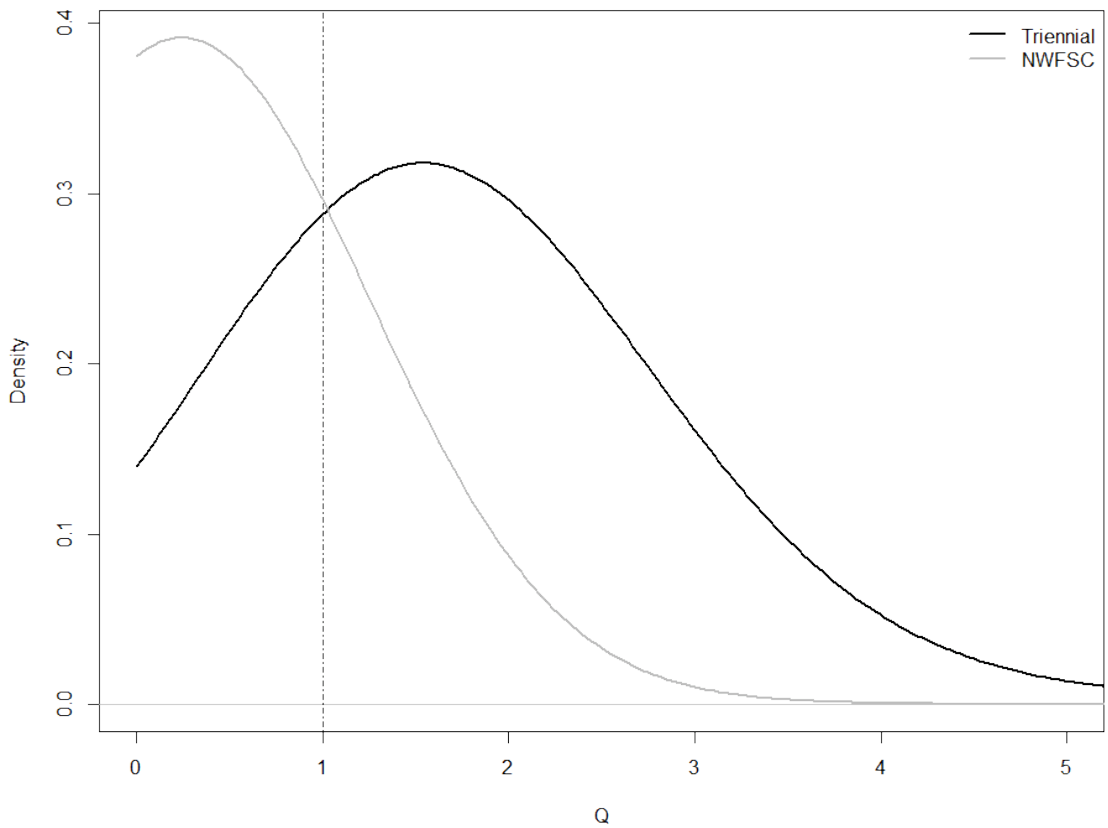

Figure 85. Posterior distribution of the catchability parameters (q) for each index fit in the exSSS AIS yellowtail rockfish (North of 40° 10' N lat.) assessment.

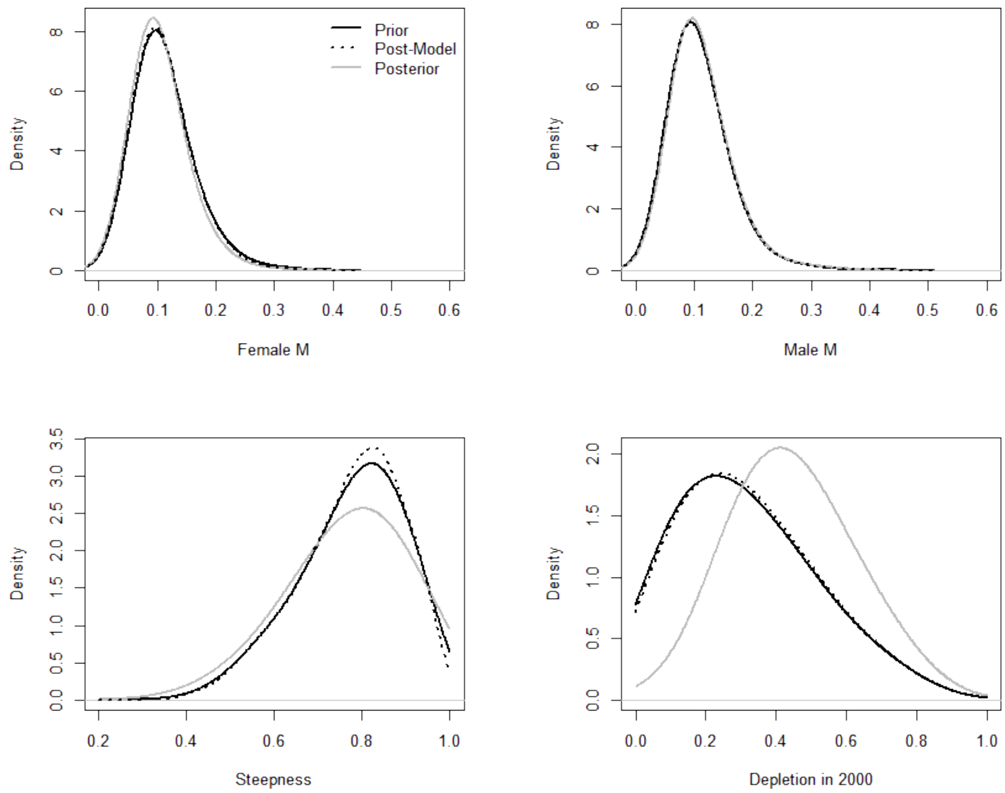

Figure 86. Prior and posterior distributions for each input parameter of the exSSS AIS uncertainty estimation for yellowtail rockfish (North of 40° 10' N lat.).

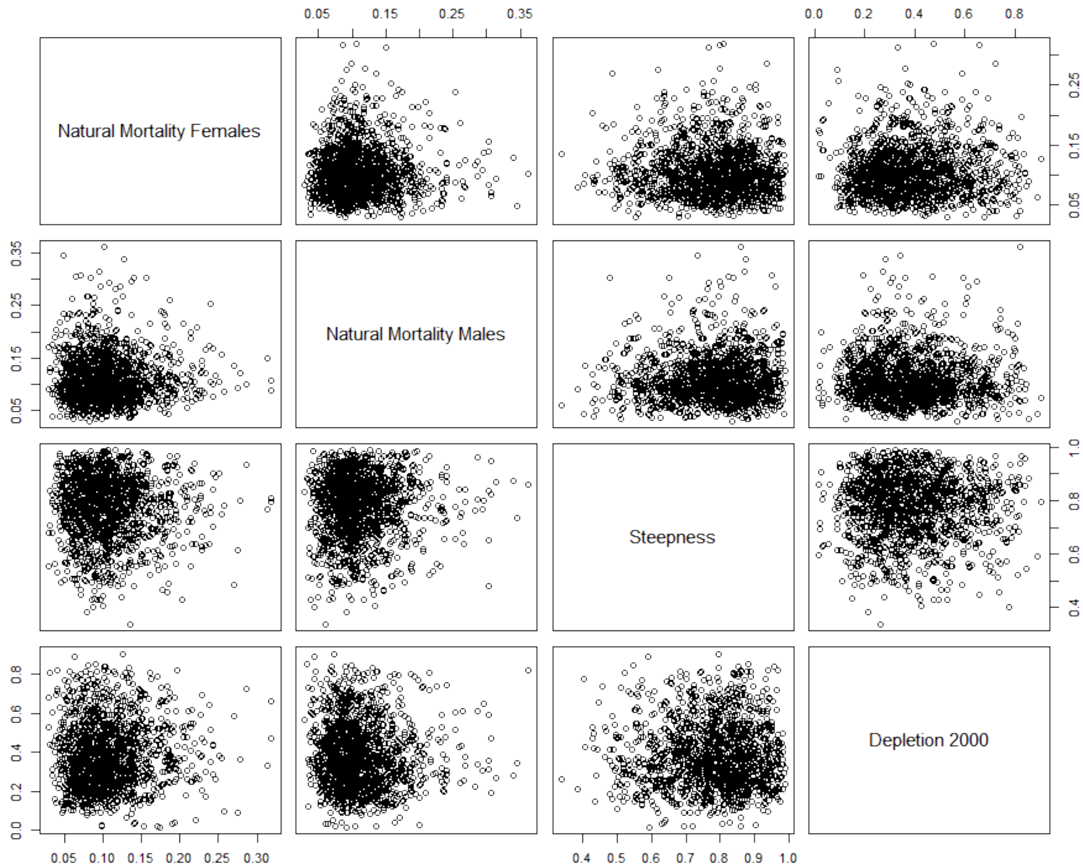

Figure 87. Pairs plots for each parameter in the exSSS AIS treatment of uncertainty for yellowtail rockfish (North of 40° 10’ N lat.).

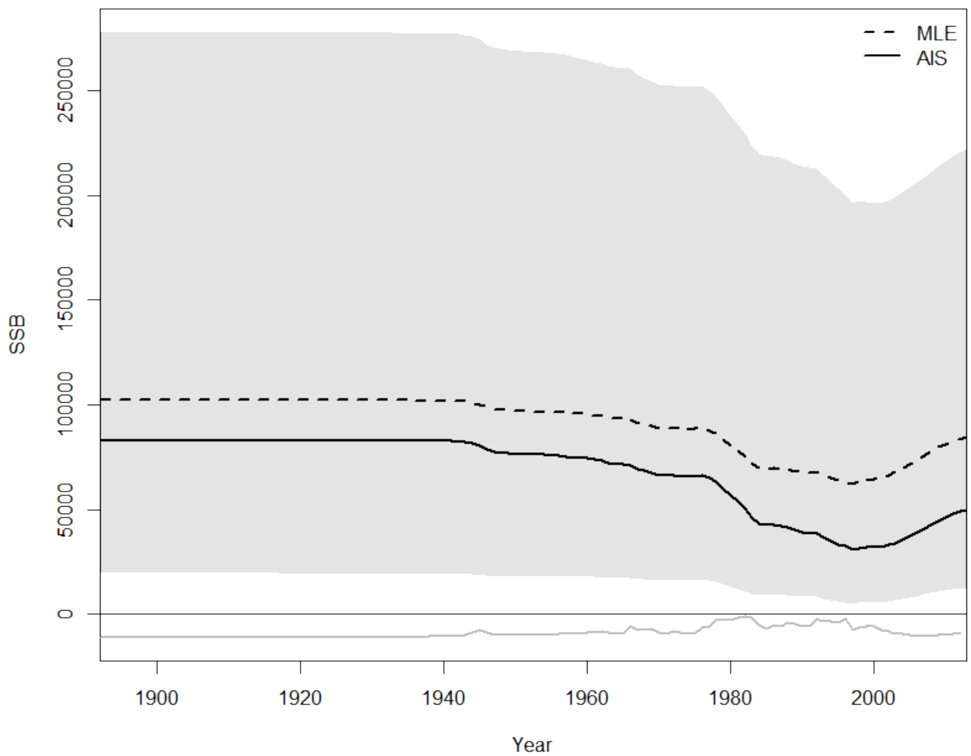

Figure 88. Time series of spawning biomass from the exSSS MLE (broken line) and AIS (solid line with gray uncertainty bars) for yellowtail rockfish (North of 40° 10’ N lat.). Catch history is provided below the 0 line.

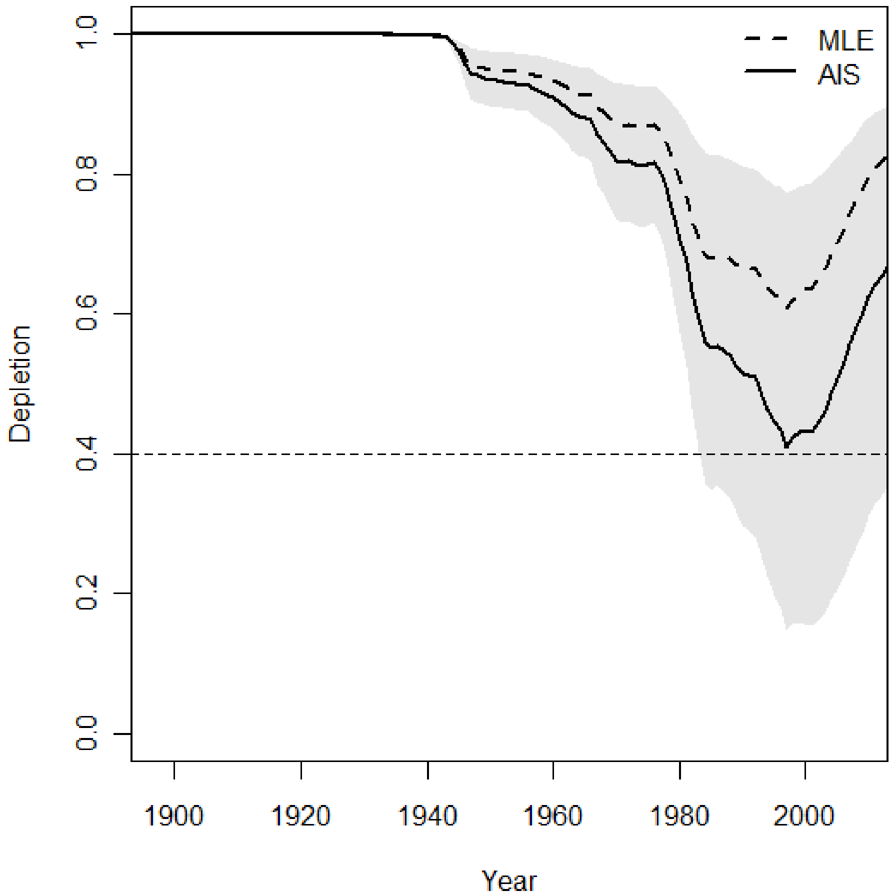

Figure 89. Time series of stock status (depletion) from the exSSS MLE (broken line) and AIS (solid line with gray uncertainty bars) for yellowtail rockfish (North of 40° 10' N lat.).

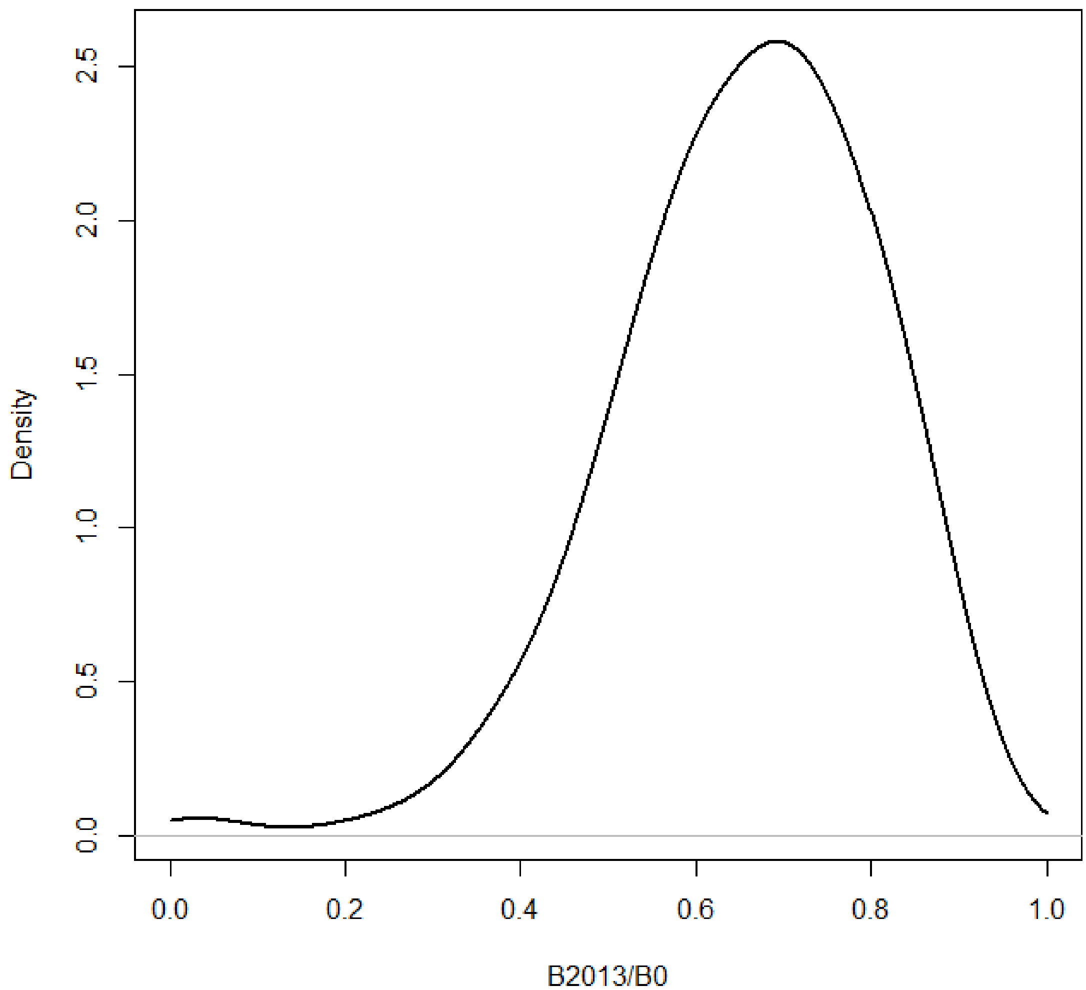

Figure 90. Stock status posterior distribution from the exSSS AIS model for yellowtail rockfish (North of 40° 10' N lat.) rockfish.

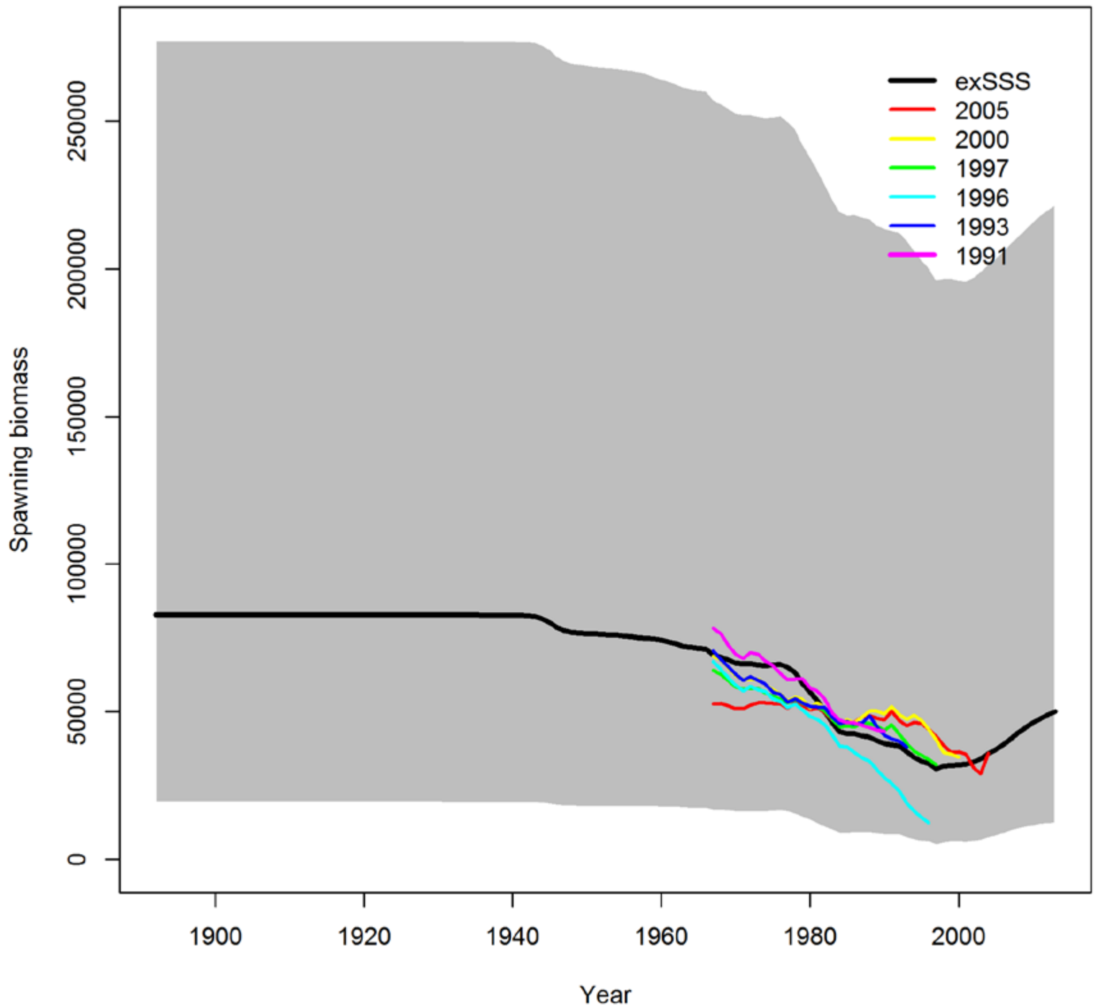

Figure 91. Comparison of exSSS estimated spawning biomass (black line with gray shading indicating the 95% CI) to past stock assessments of the yellowtail rockfish (North of 40° 10' N lat.).

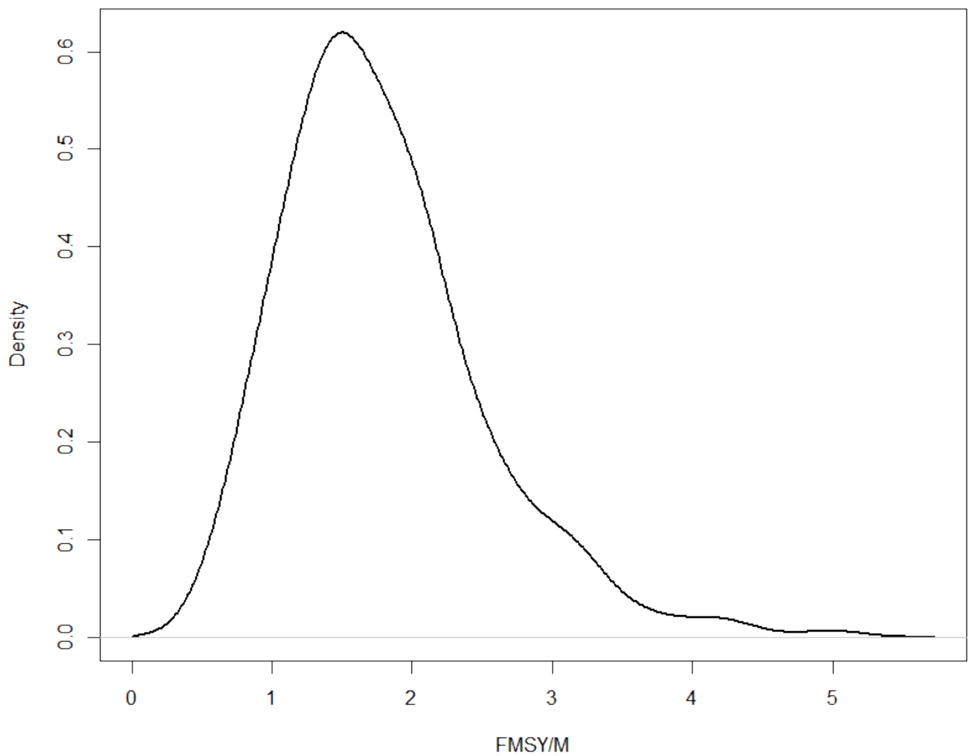

Figure 92. Posterior distribution of F_{MSY}/M from the exSSS AIS model for yellowtail rockfish (North of 40° 10’ N lat.).

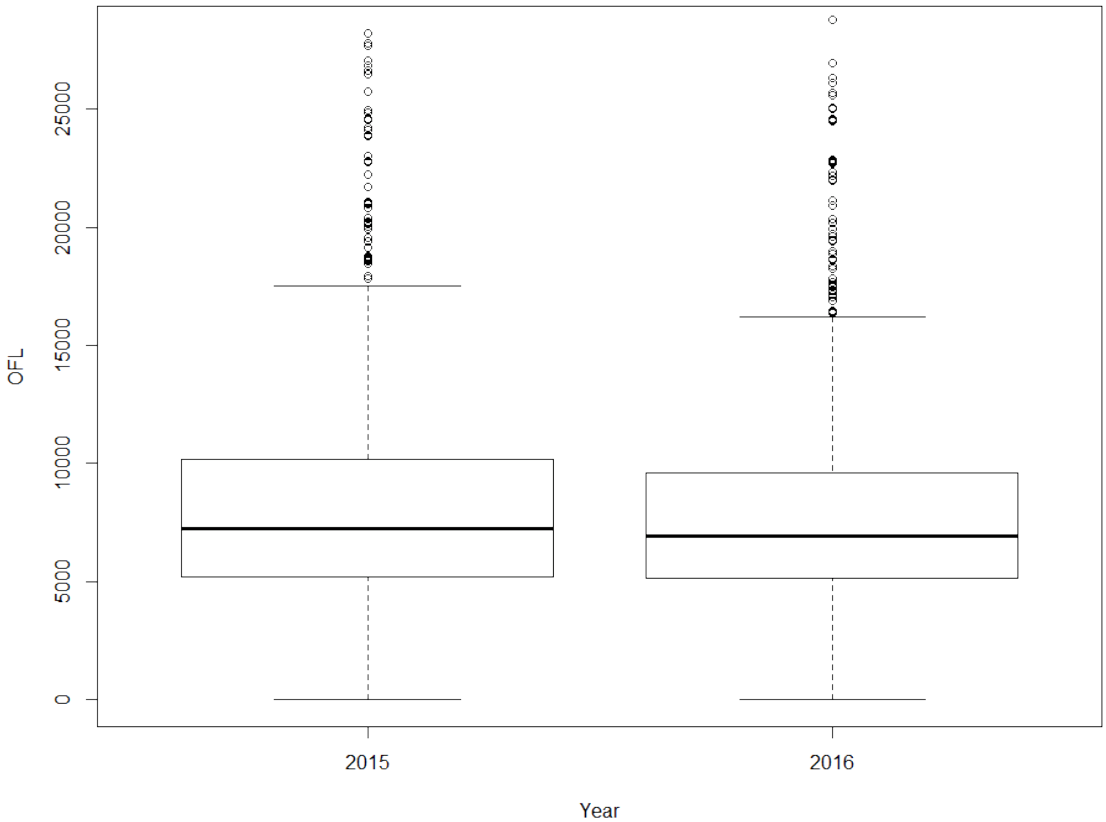

Figure 93. Posterior distribution of OFLs **from the exSSS AIS model for yellowtail rockfish (North of 40° 10’ N lat.).**

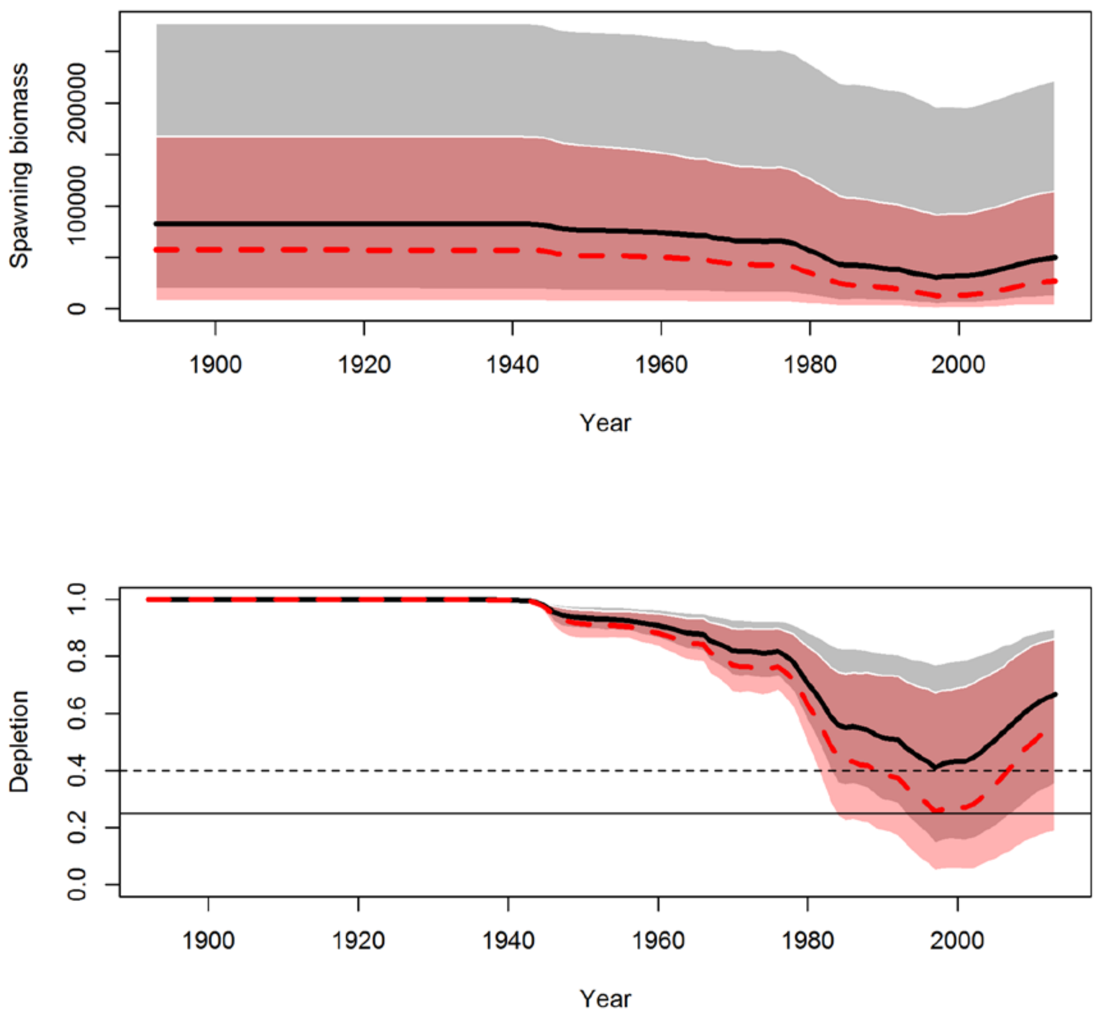

Figure 94. Comparison of the exSSS AIS (black line, gray shaded 95% CI) and catch-only (SSS; red broken line; pink shaded 95% CI) estimates of spawning biomass (upper panel) and stock status (lower panel) for yellowtail rockfish (North of 40° 10’ N lat.). Darker red shaded area is the overlap of the top models.

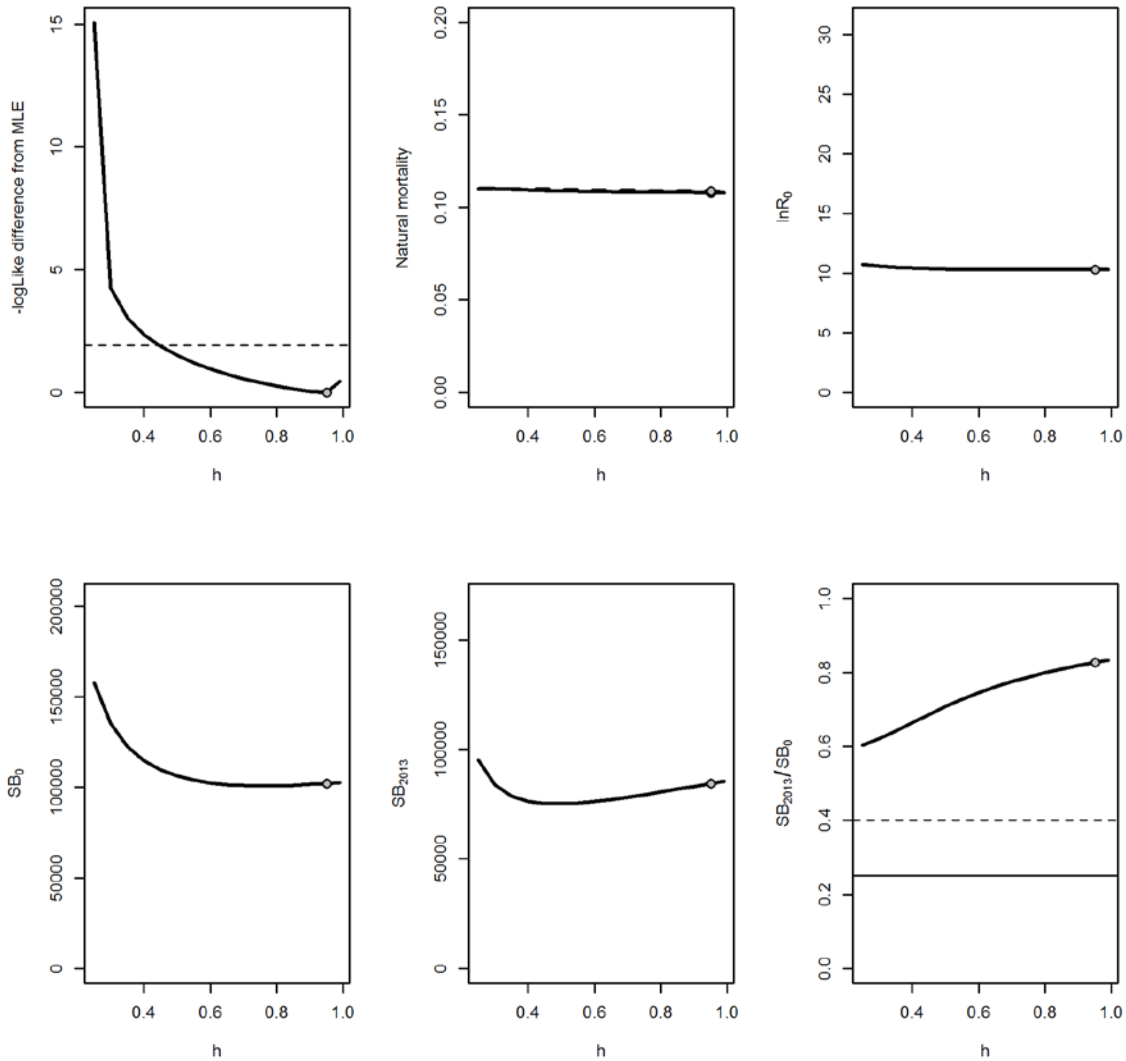

Figure 95. Likelihood profile for steepness (h; top left panel) and sensitivity to h of estimated (top center and right panels) and derived assessment outputs (bottom panels) for yellowtail rockfish (North of 40° 10' N lat.) using exSSS. The MLE is indicated by the circle. Top left panel: broken line is 95% interval; Top middle panel: solid and broken lines are the female and male *M* values; Bottom right panel: Solid and broken line are the target and limit biomass reference points.

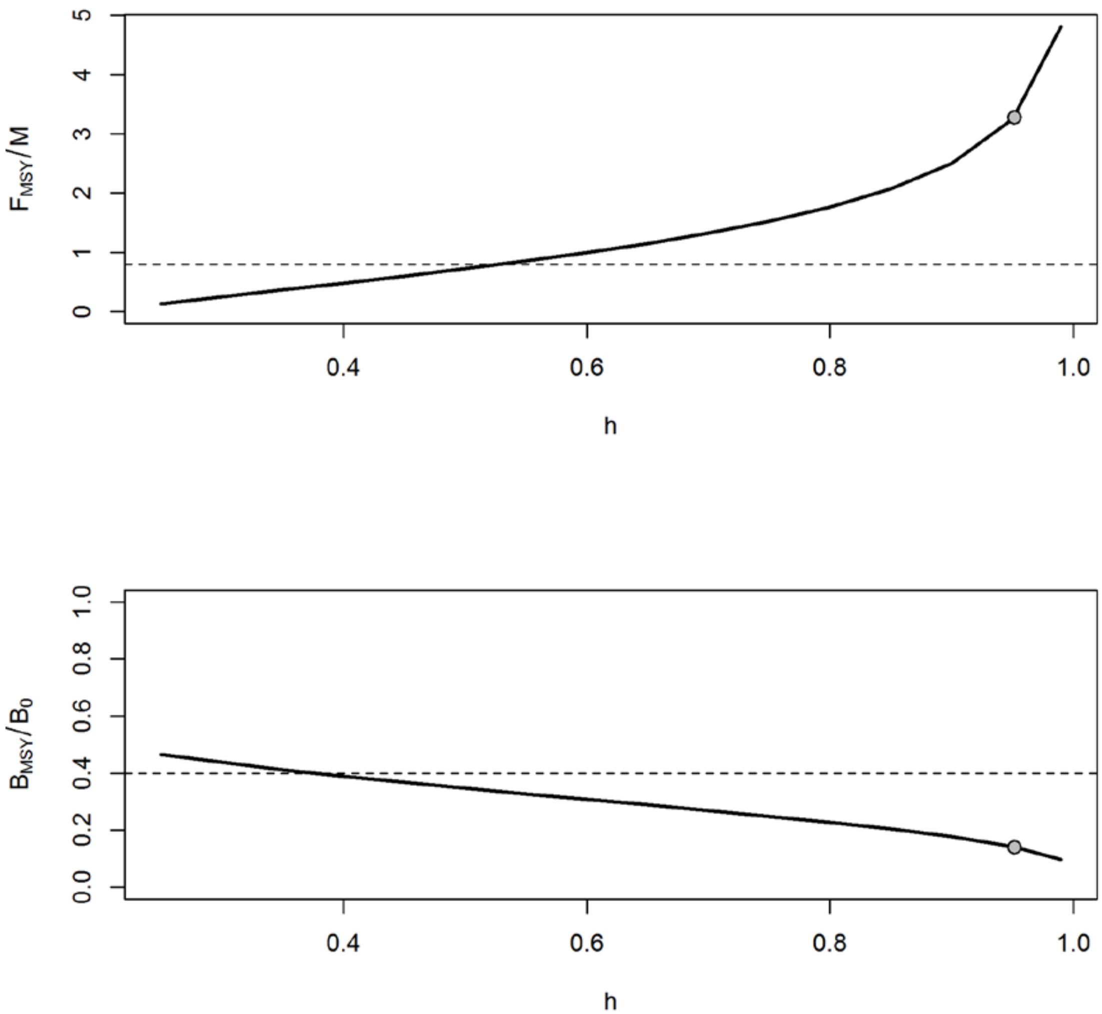

Figure 96. Steepness profile relative to XDB-SRA productivity parameters F_{MSY}/M (top panel) and B_{MSY}/B_0 (bottom panel) for yellowtail rockfish (North of 40° 10' N lat.). Circle indicates exSSS MLE estimate. Broken line is the prior mean used in XDB-SRA.

8.2.6 English sole

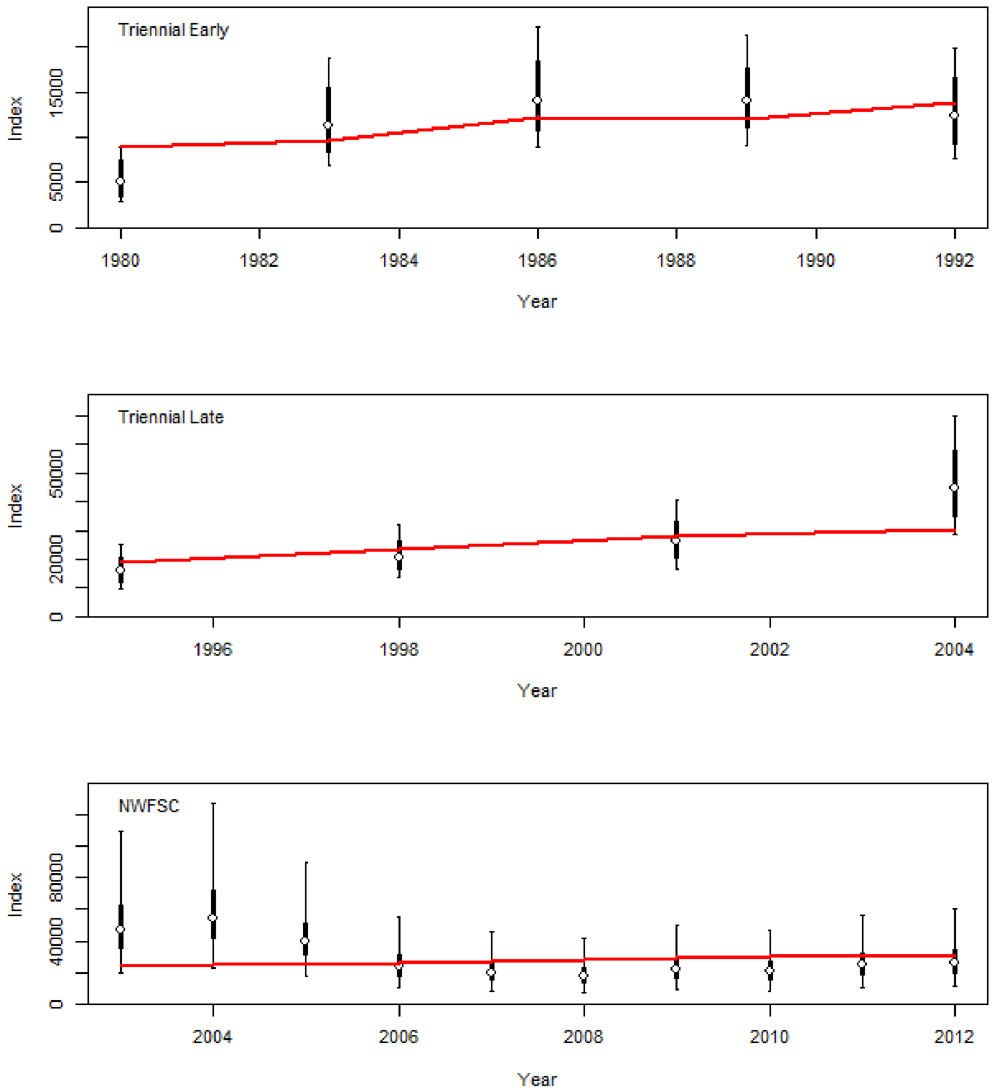

Figure 97. Fits to the three fishery-independent surveys from the exSSS AIS model for English sole. Thick lines are inputted variance; thin lines are estimated added variance.

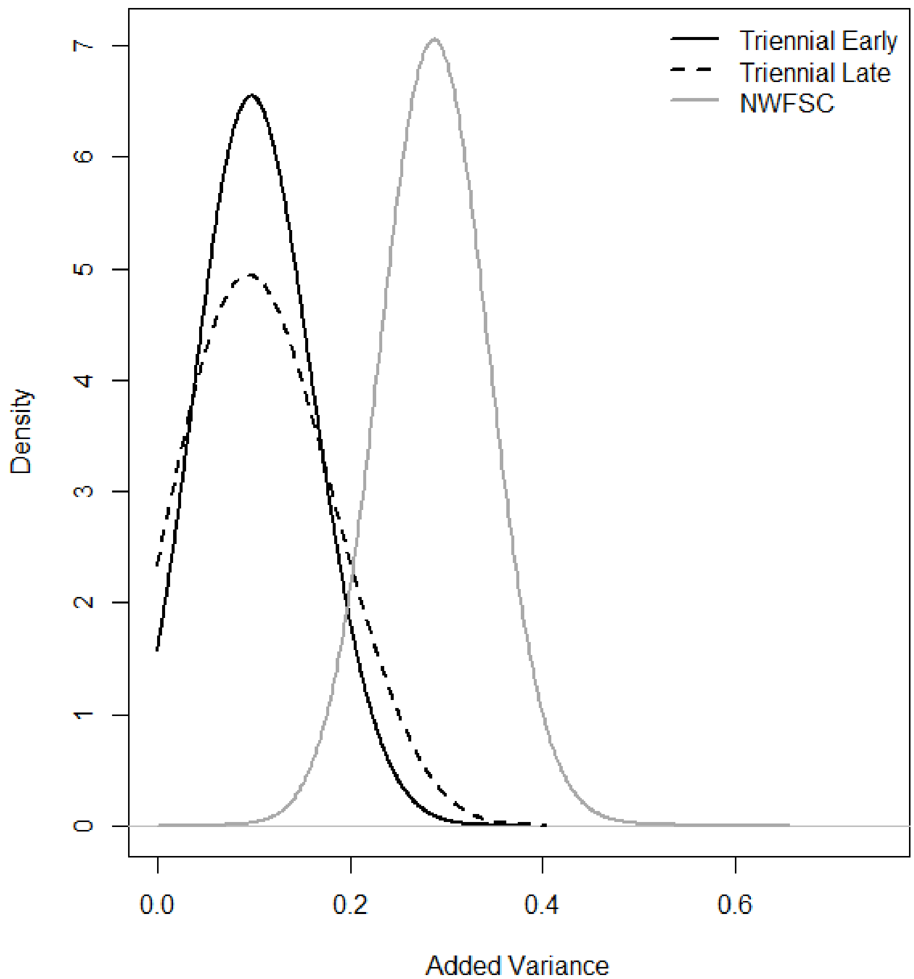

Figure 98. Posterior distribution of the added variance for each index fit in the exSSS AIS English sole assessment.

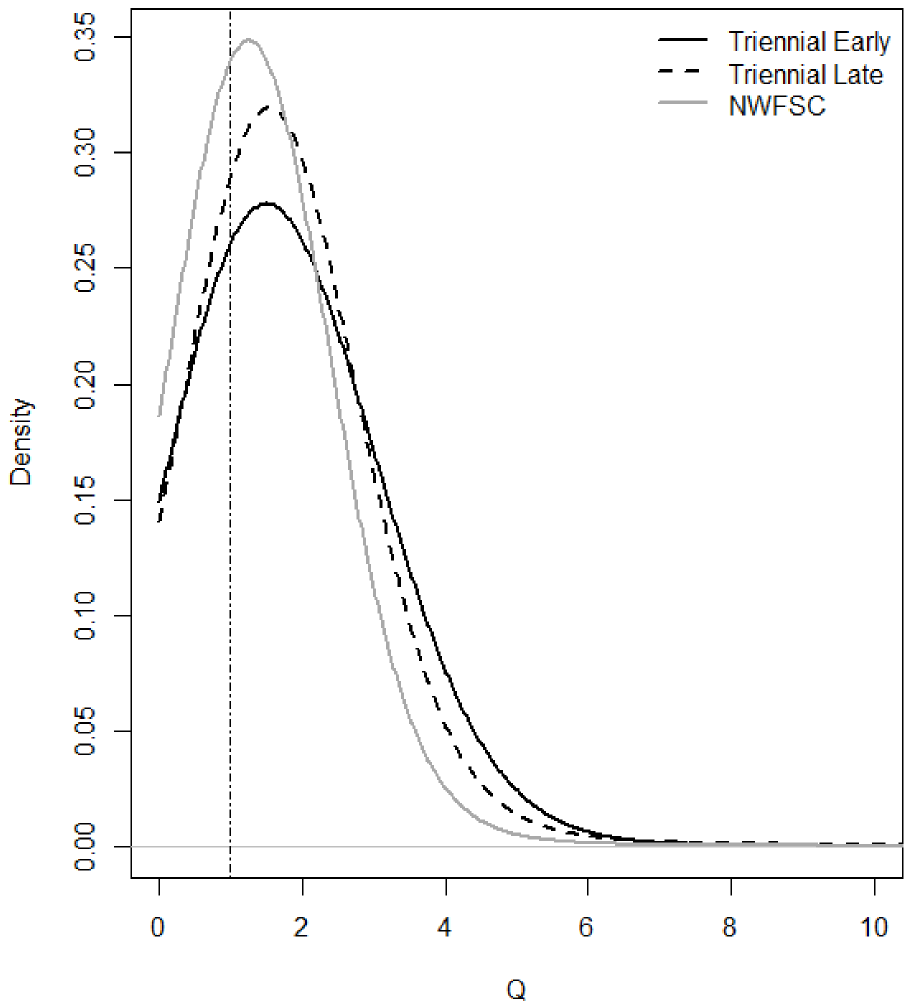

Figure 99. Posterior distribution of the catchability parameters (q) for each index fit in the exSSS AIS English sole assessment. Vertical line indicates q=1.

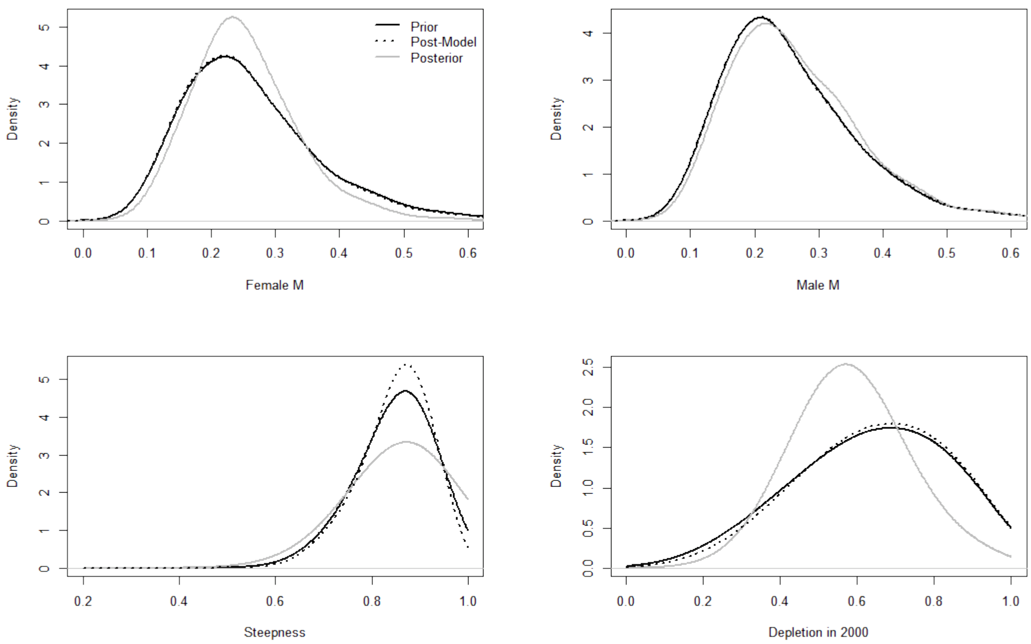

Figure 100. Prior and posterior distributions for each input parameter of the exSSS AIS uncertainty estimation for English sole.

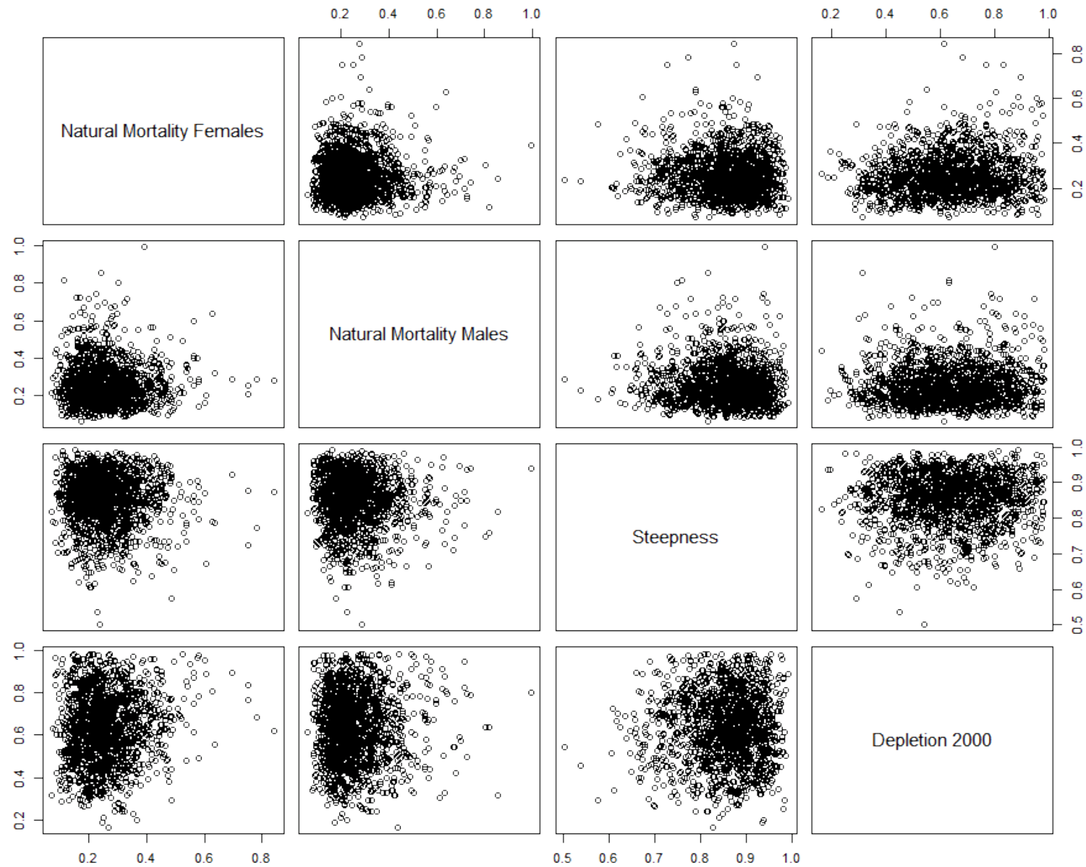

Figure 101. Pairs plots for each parameter in the exSSS AIS treatment of uncertainty for English sole.

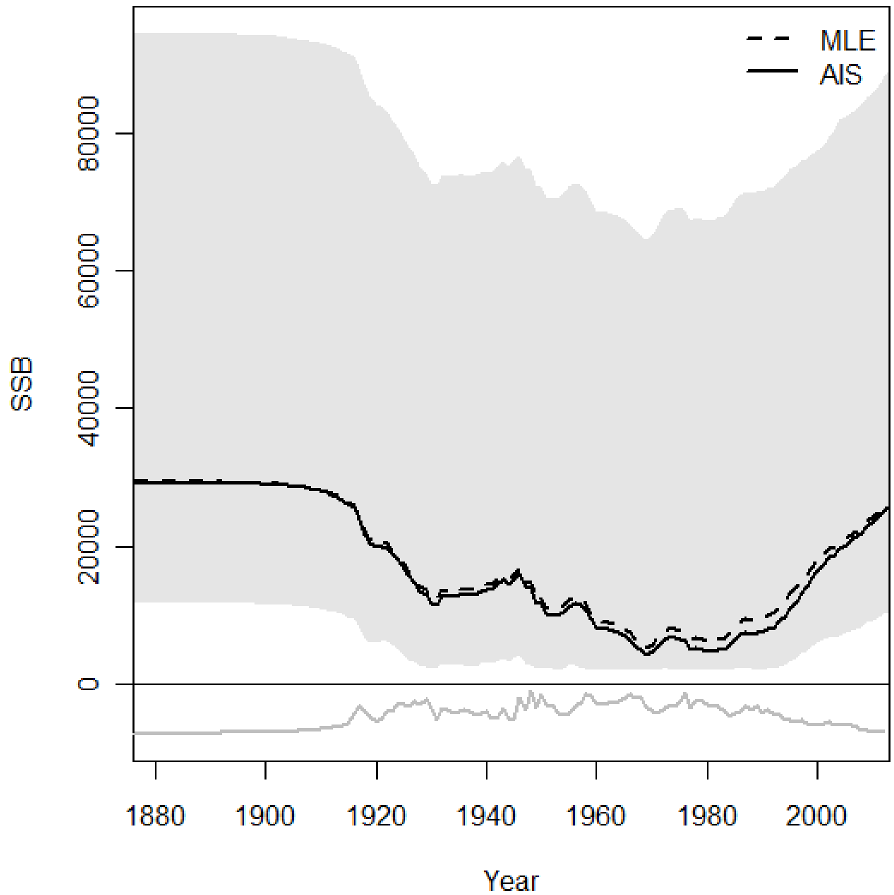

Figure 102. Time series of spawning biomass from the exSSS MLE (broken line) and AIS (solid line with gray uncertainty bars) for English sole. Catch history is provided below the 0 line.

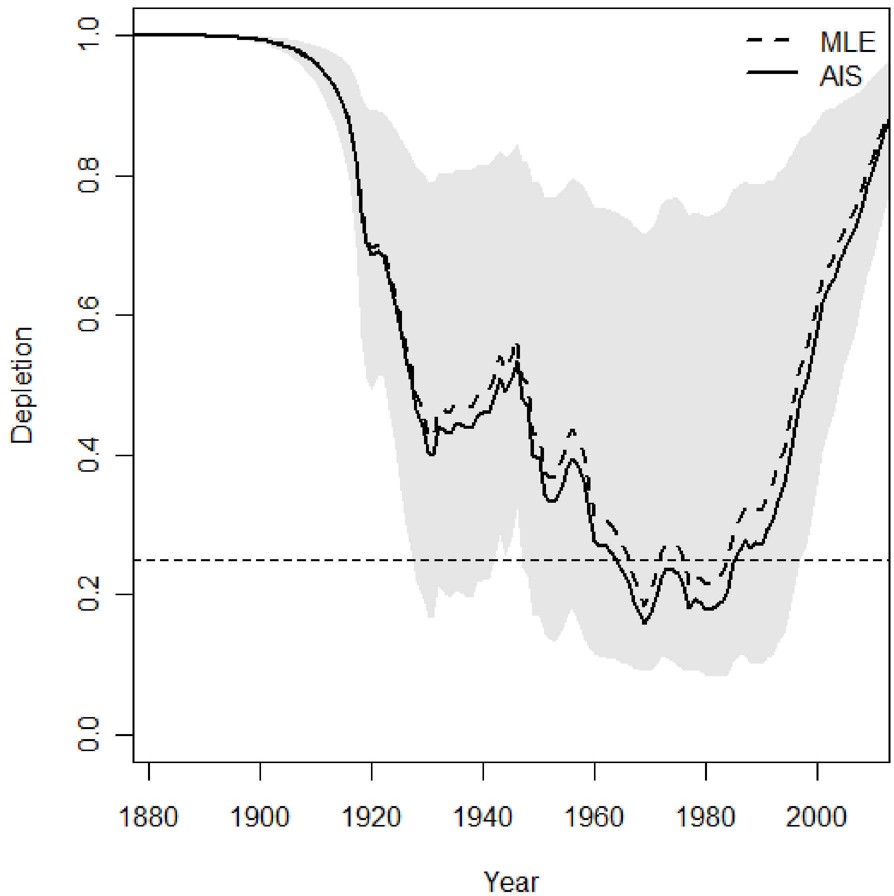

Figure 103. Time series of stock status (depletion) from the exSSS MLE (broken line) and AIS (solid line with gray uncertainty bars) for English sole.

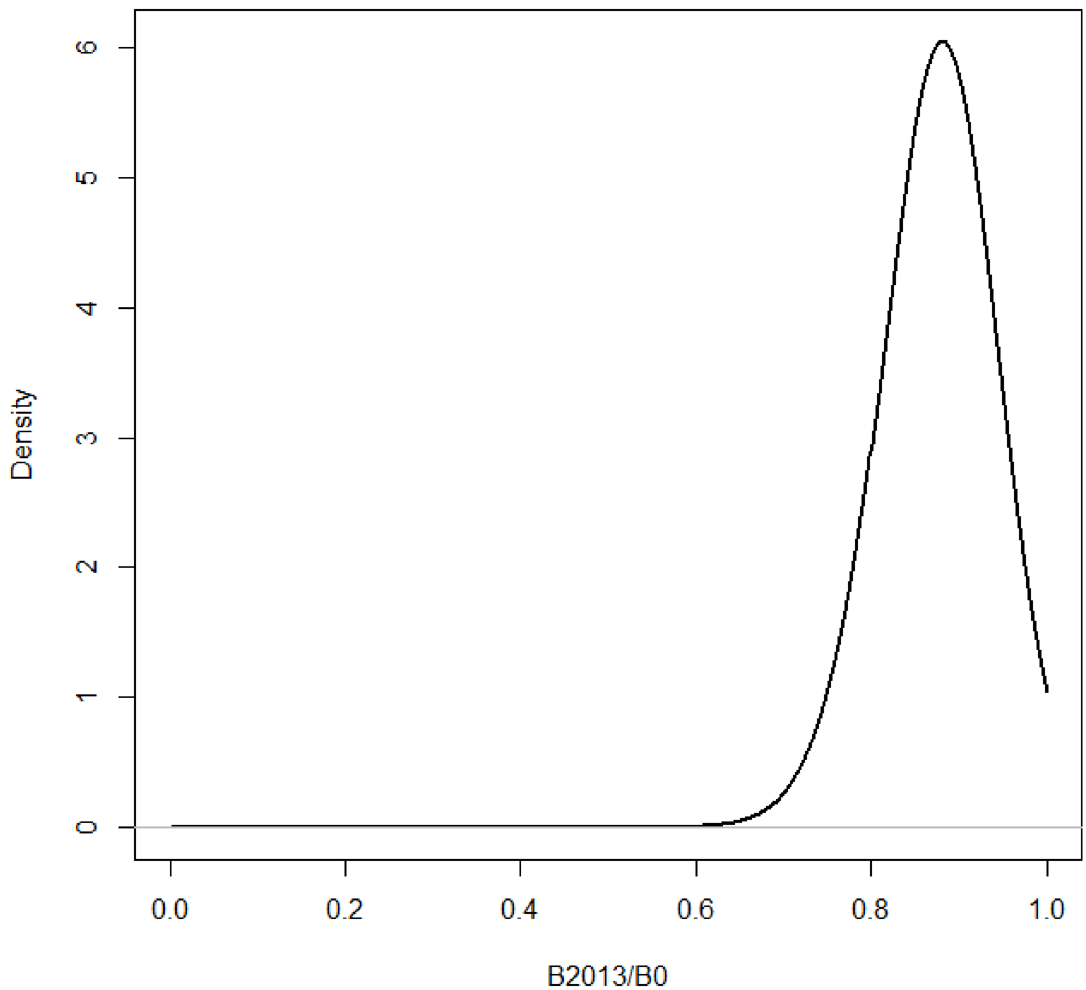

Figure 104. Stock status posterior distribution from the exSSS AIS model for English sole.

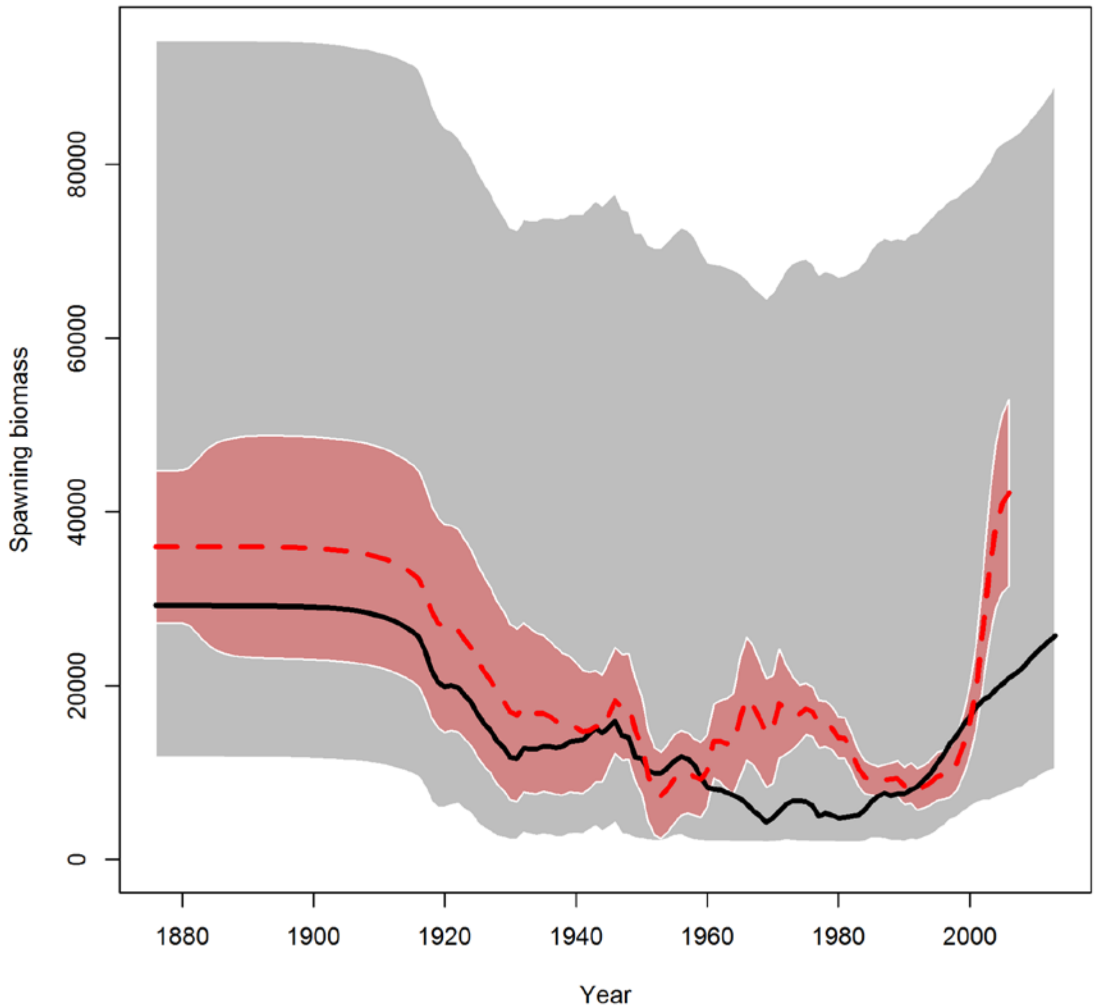

Figure 105. Comparison of the exSSS model (black line with gray shading of 95% CI) to the 2009 full assessment (red broken line with red shading of 95% CI) of English sole.

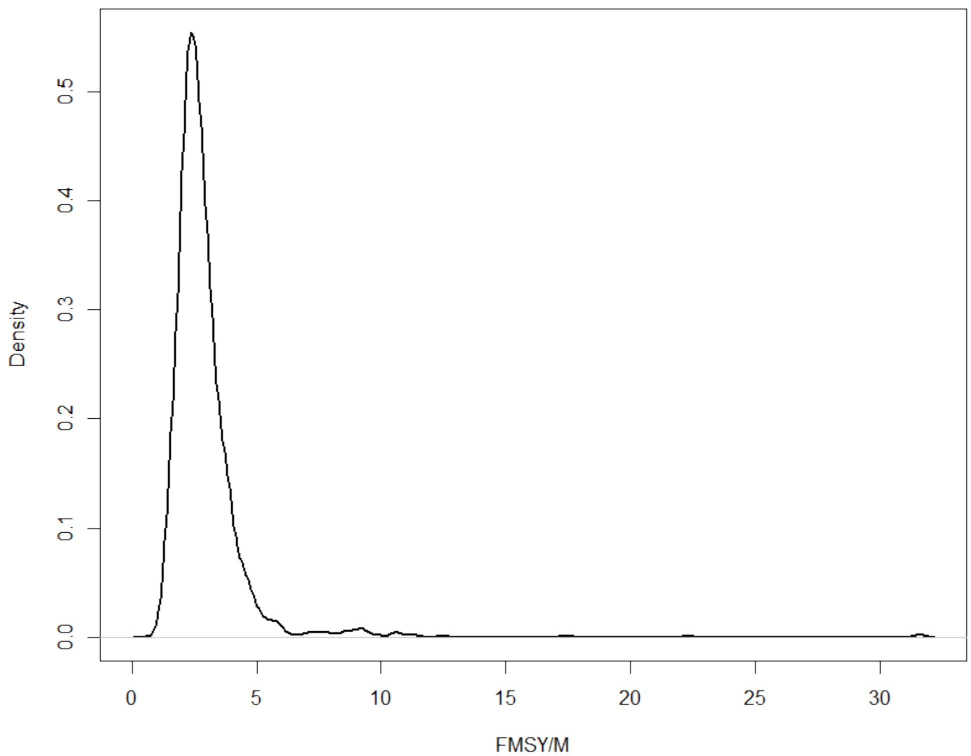

Figure 106. Posterior distribution of F_{MSY}/M from the exSSS AIS model for English sole.

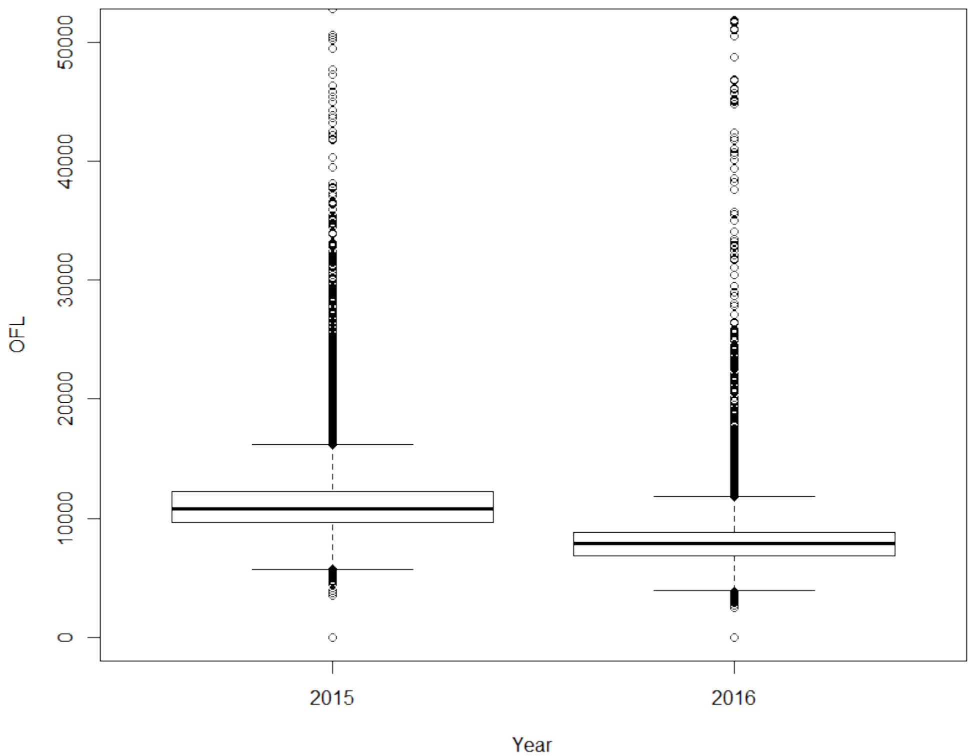

Figure 107. Posterior distribution of OFLs **from the exSSS AIS model for English sole.**

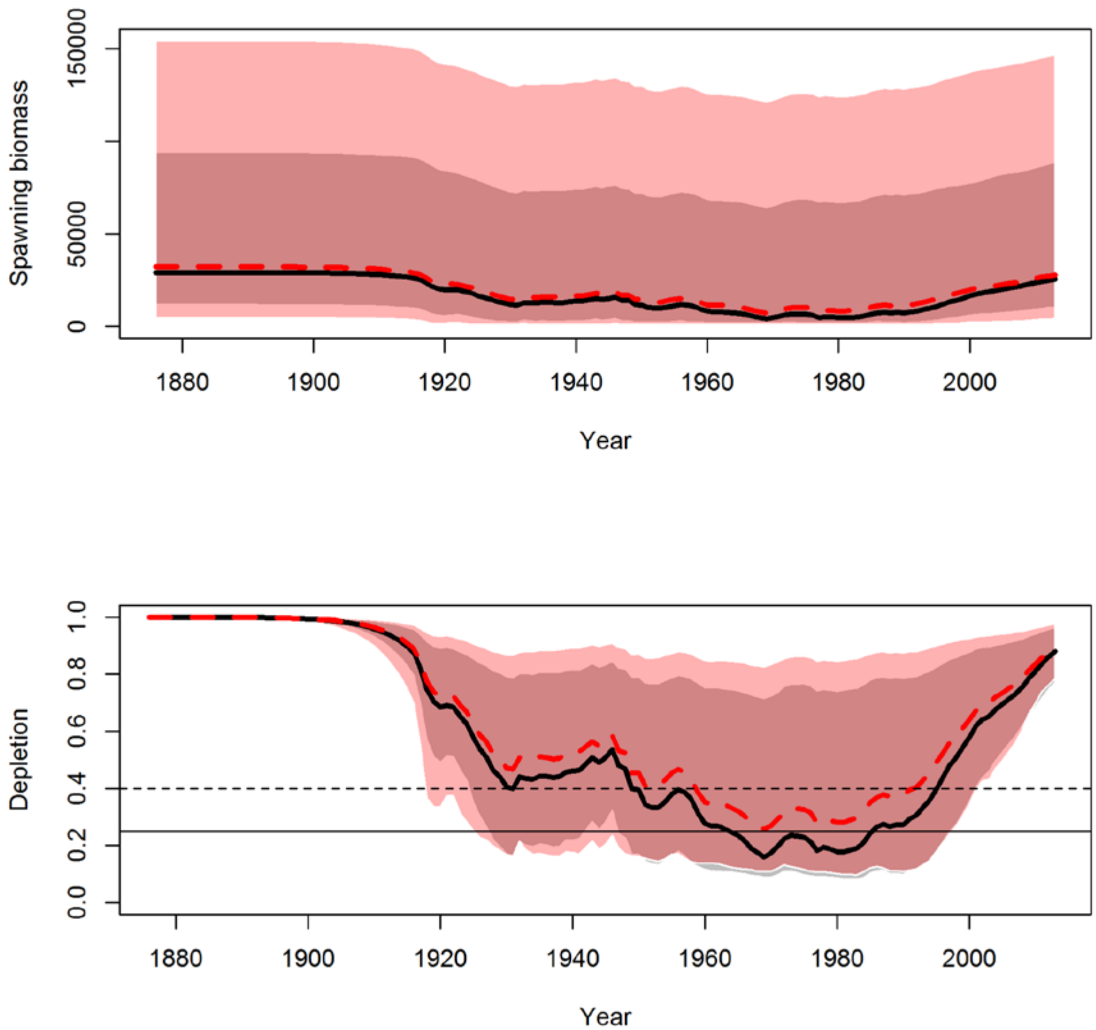

Figure 108. Comparison of the exSSS AIS (black line, gray shaded 95% CI) and catch-only (SSS; red broken line; pink shaded 95% CI) estimates of spawning biomass (upper panel) and stock status (lower panel) for English sole. Darker red shaded area is the overlap of the top models.

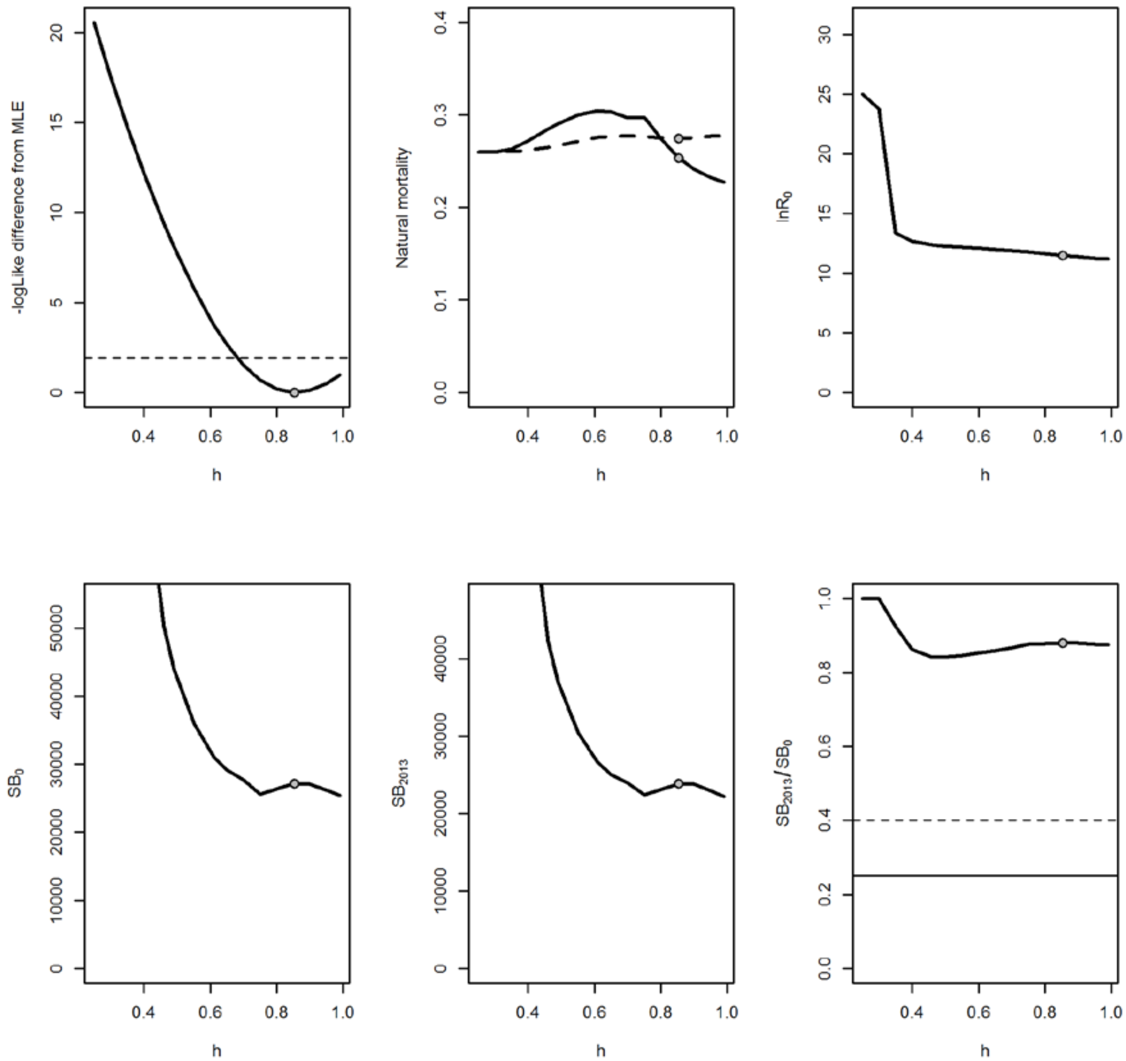

Figure 109. Likelihood profile for steepness (*h*; top left panel) and sensitivity to *h* of estimated (top center and right panels) and derived assessment outputs (bottom panels) for English sole using exSSS. The MLE is indicated by the circle. Top left panel: broken line is 95% interval; Top middle panel: solid and broken lines are the female and male *M* values; Bottom right panel: Solid and broken line are the target and limit biomass reference points.

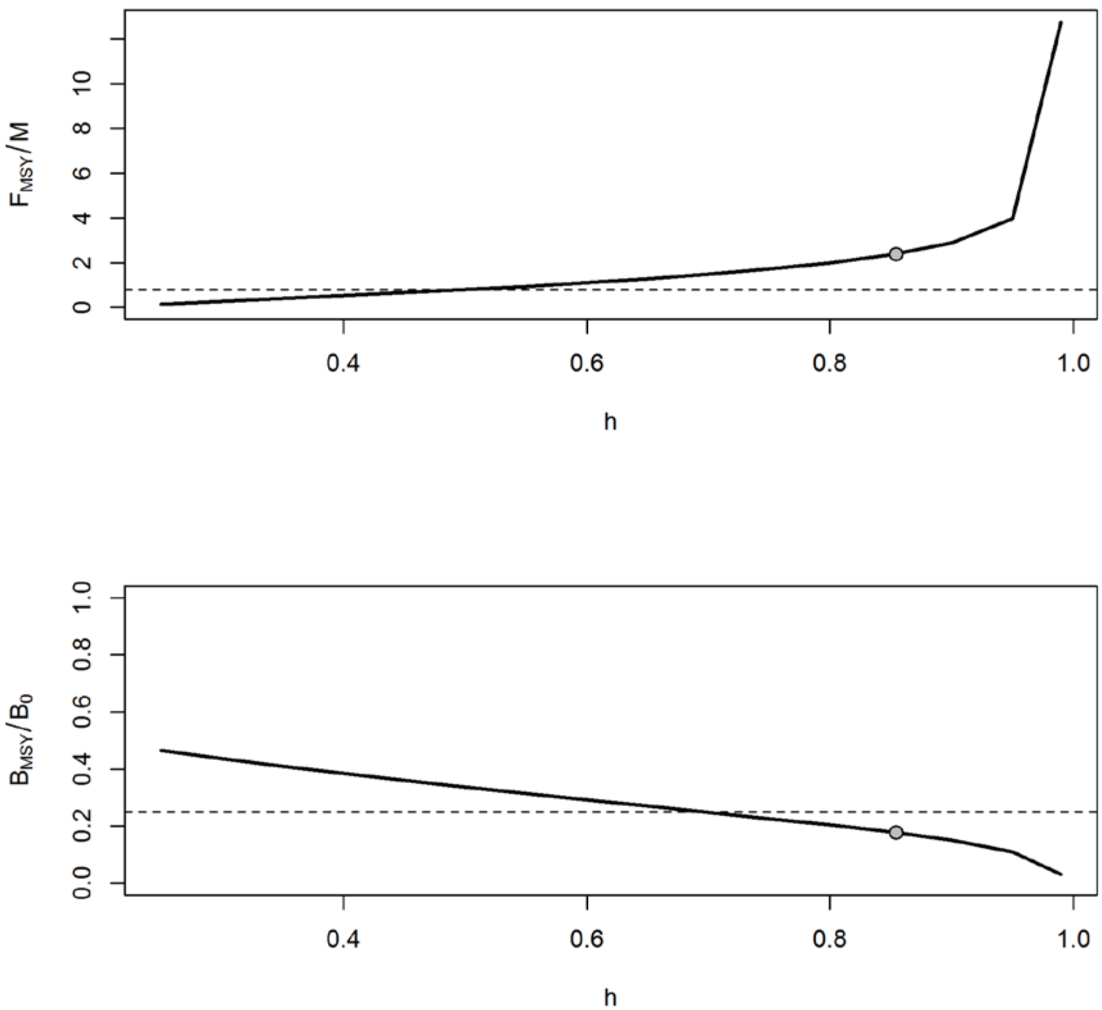

Figure 110. Steepness profile relative to XDB-SRA productivity parameters F_{MSY}/M (top panel) and B_{MSY}/B_0 (bottom panel) for English sole. Circle indicates exSSS MLE estimate. Broken line is the prior mean used in XDB-SRA.

8.2.7 Rex sole

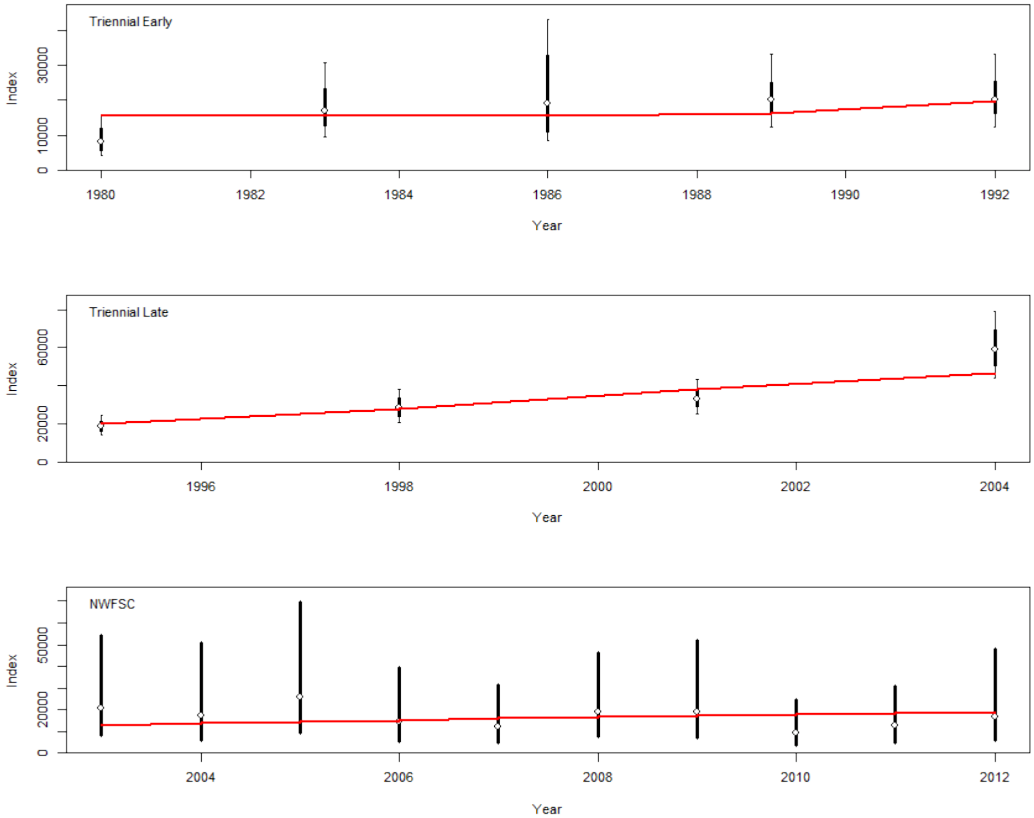

Figure 111. Fits to the three fishery-independent surveys from the exSSS AIS model for rex sole. Thick lines are inputted variance; thin lines are estimated added variance.

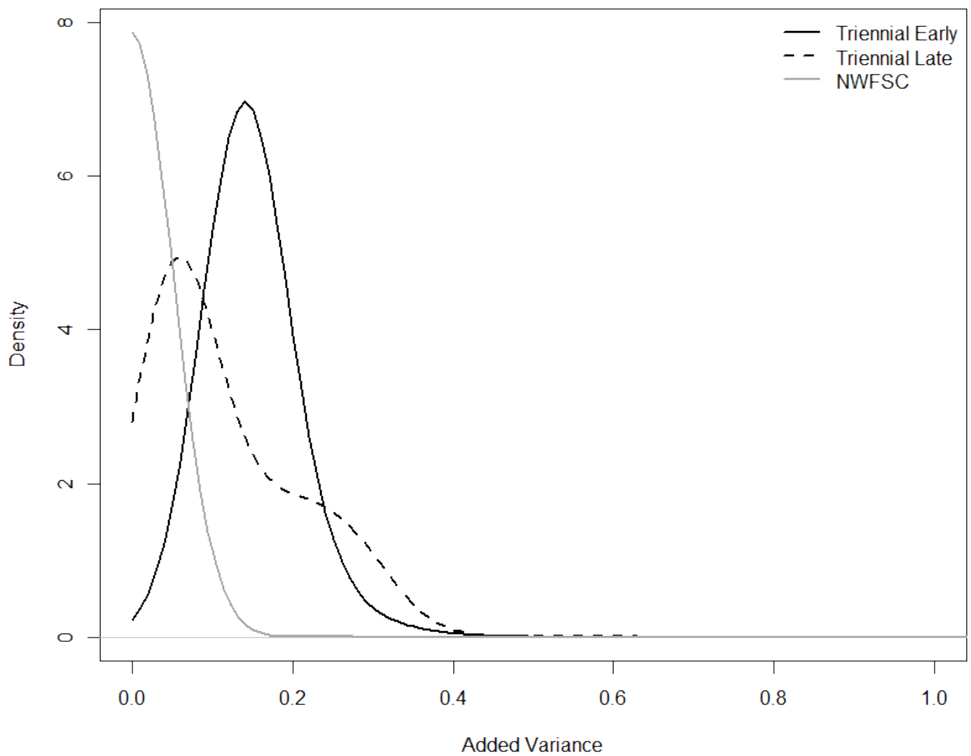

Figure 112. Posterior distribution of the added variance for each index fit in the exSSS AIS rex sole assessment.

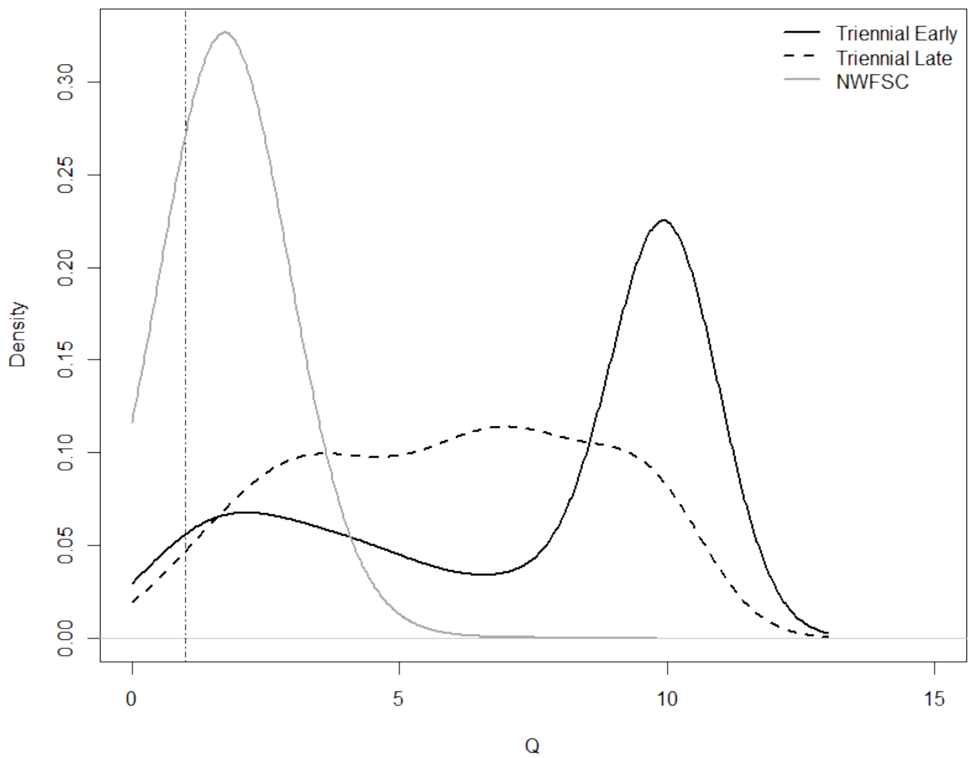

Figure 113. Posterior distribution of the catchability parameters (q) for each index fit in the exSSS AIS rex sole assessment. Vertical line indicates q=1.

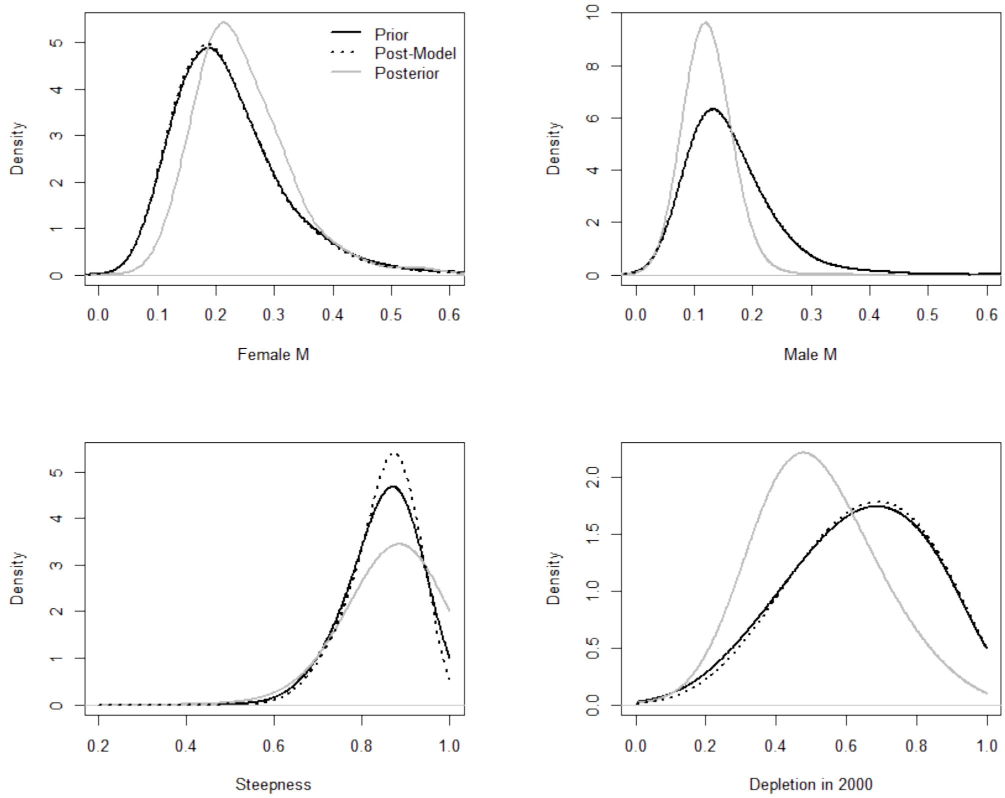

Figure 114. Prior and posterior distributions for each input parameter of the exSSS AIS uncertainty estimation for rex sole.

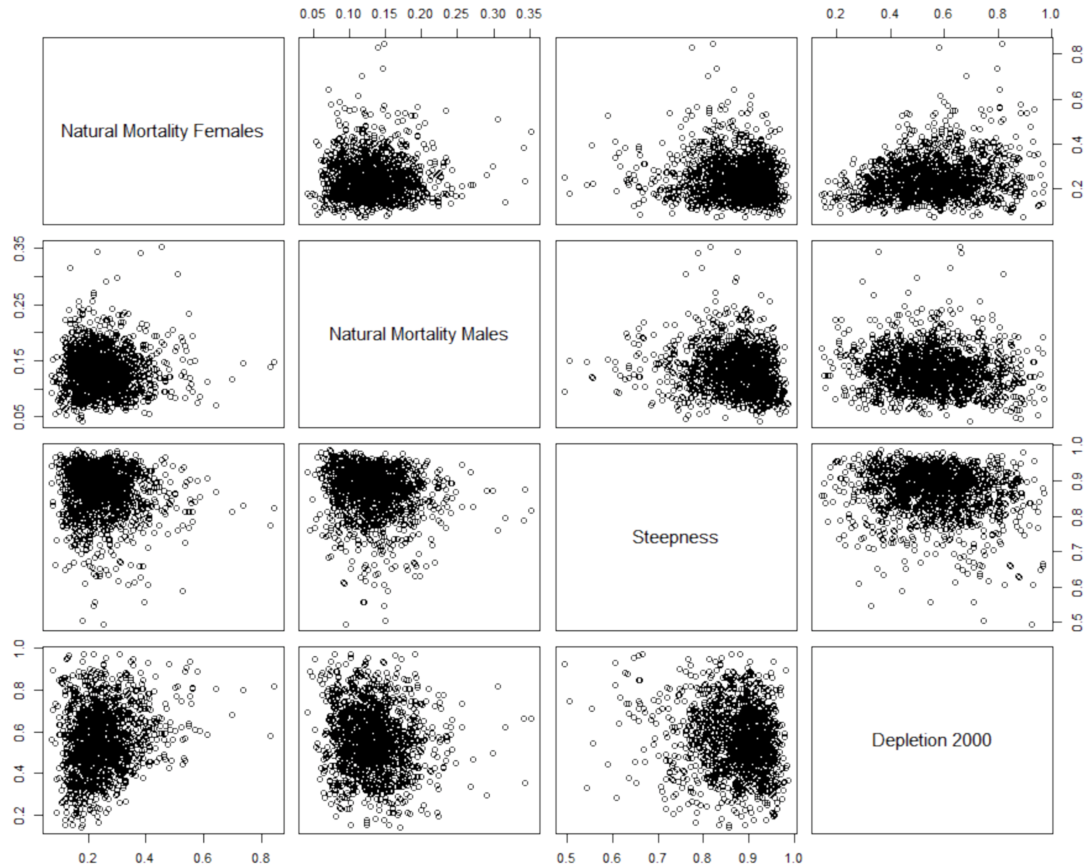

Figure 115. Pairs plots for each parameter in the exSSS AIS treatment of uncertainty for rex sole.

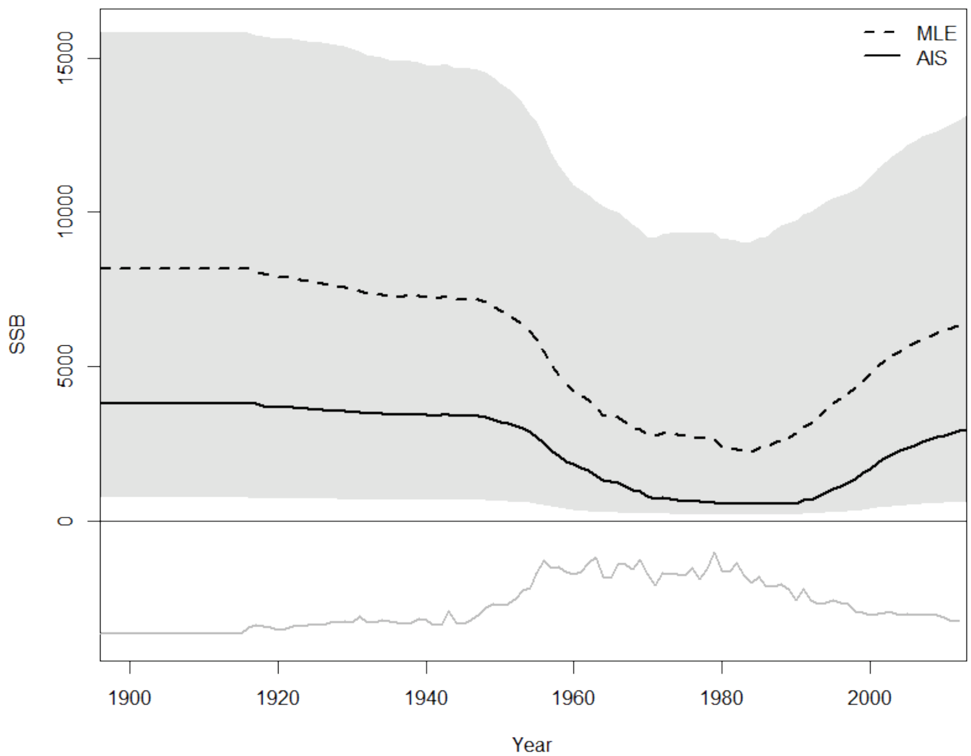

Figure 116. Time series of spawning biomass from the exSSS MLE (broken line) and AIS (solid line with gray uncertainty bars) for rex sole. Catch history is provided below the 0 line.

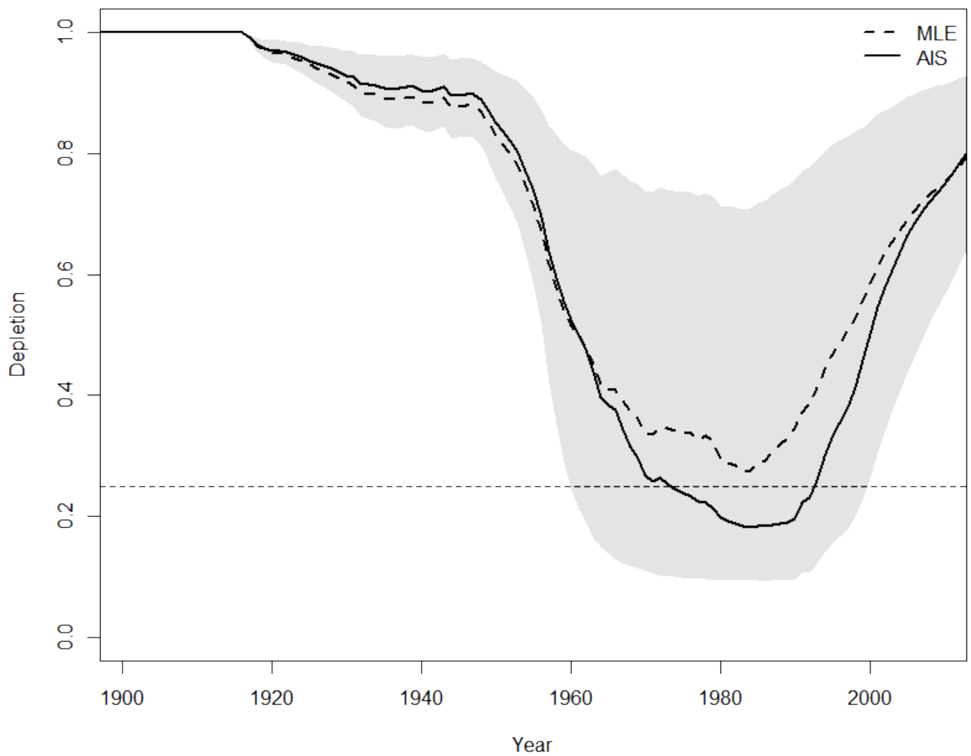

Figure 117. Time series of stock status (depletion) from the exSSS MLE (broken line) and AIS (solid line with gray uncertainty bars) for rex sole.

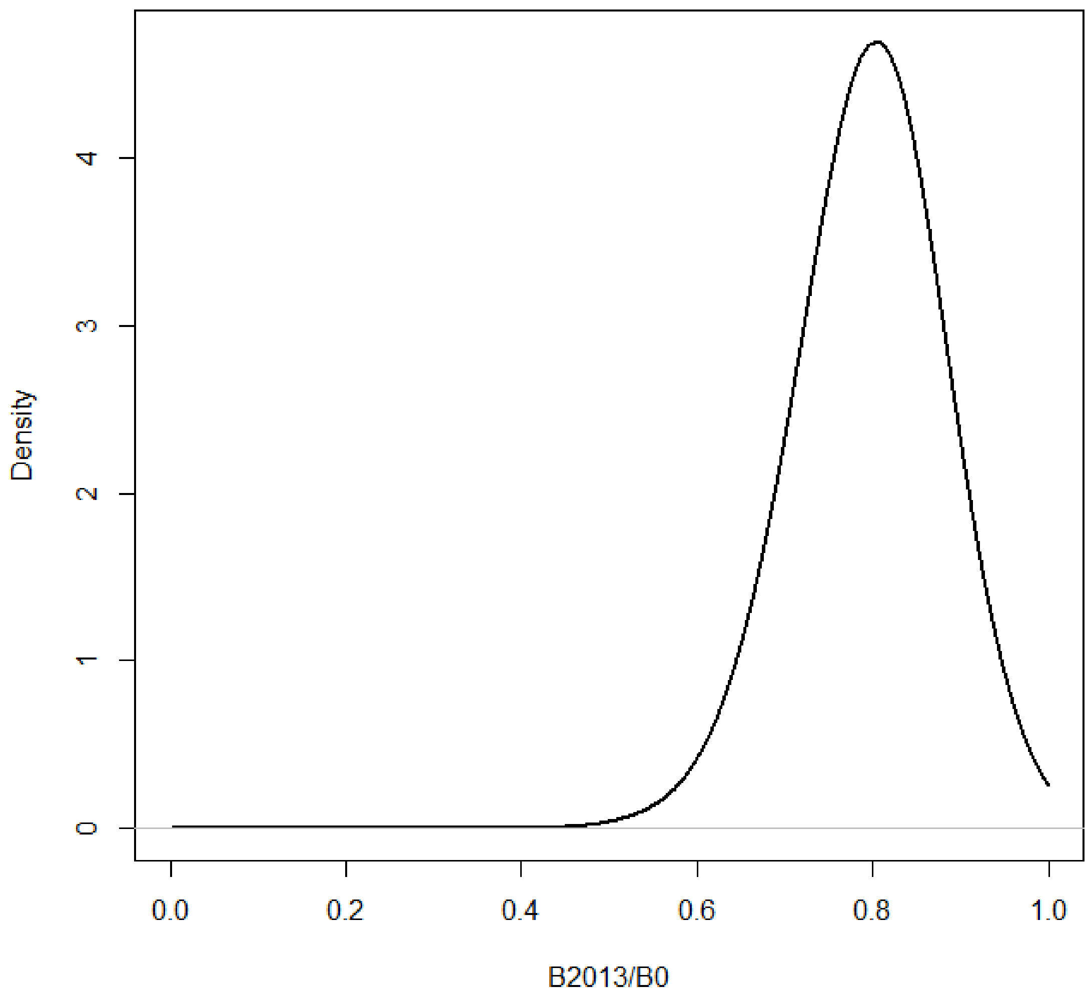

Figure 118. Stock status posterior distribution from the exSSS AIS model for rex sole.

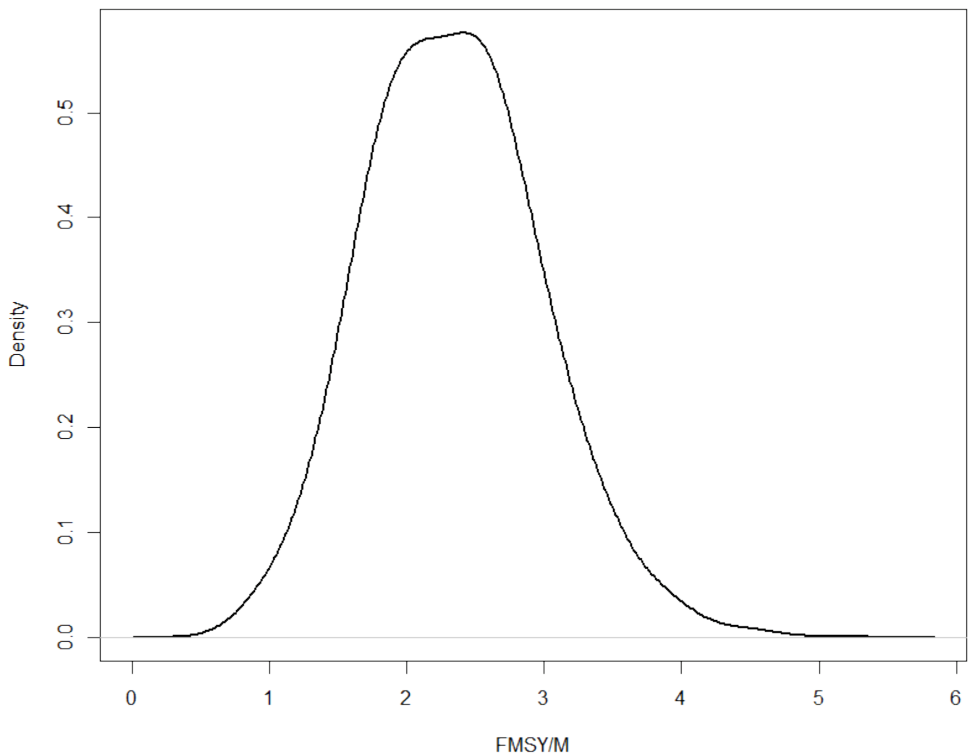

Figure 119. Posterior distribution of F_{MSY}/M from the exSSS AIS model for rex sole.

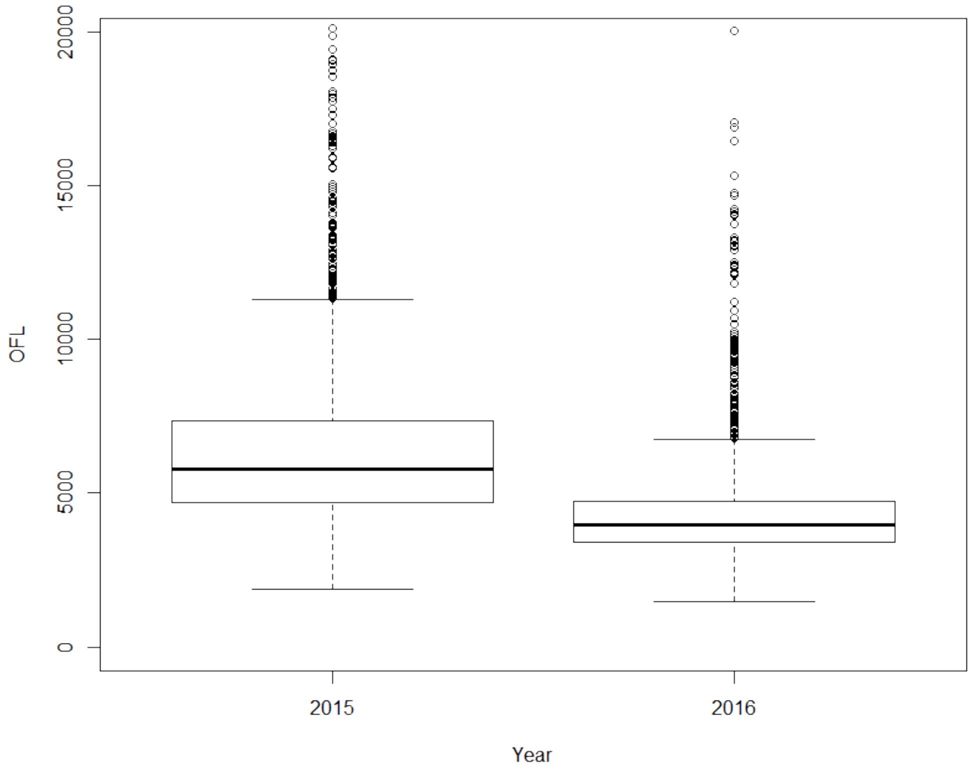

Figure 120. Posterior distribution of OFLs **from the exSSS AIS model for rex sole.**

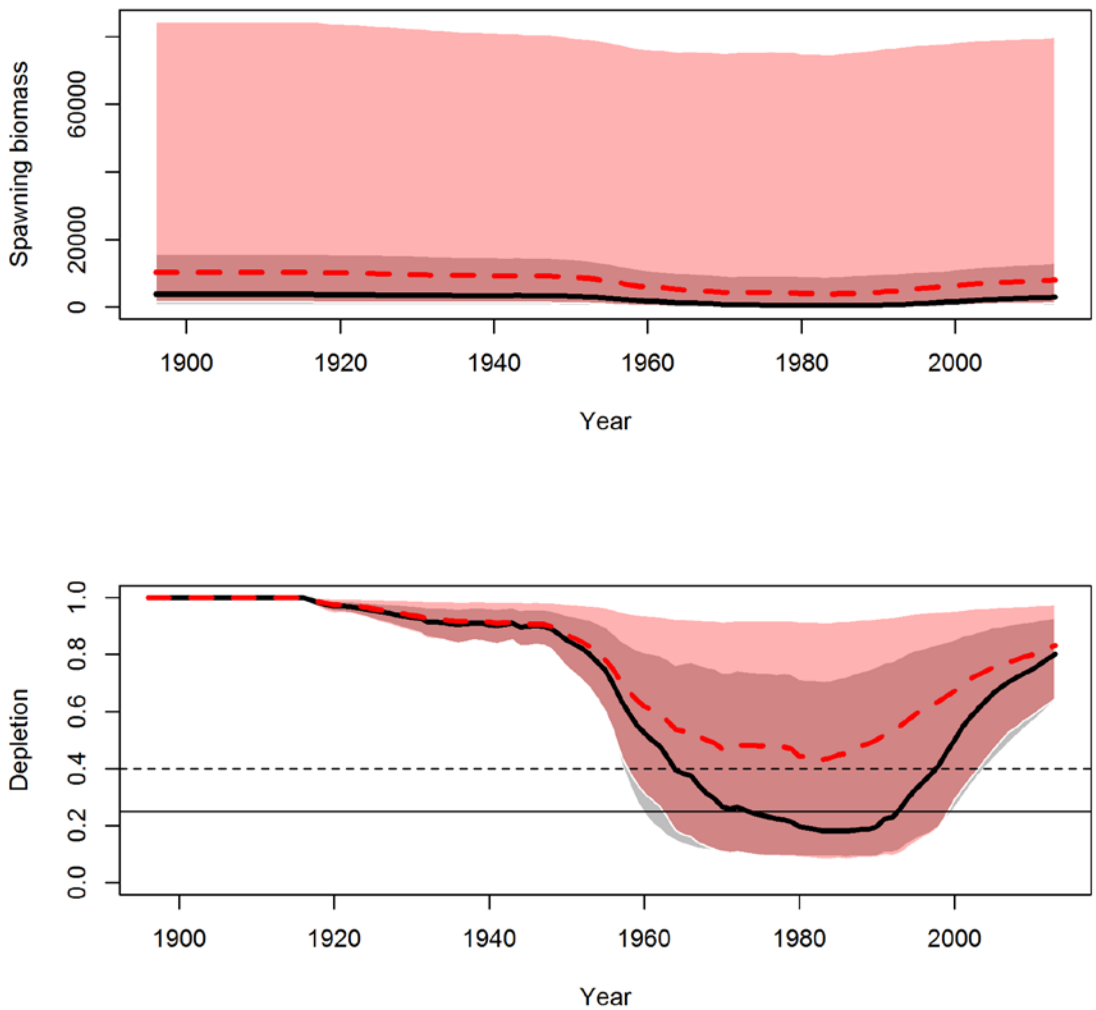

Figure 121. Comparison of the exSSS AIS (black line, gray shaded 95% CI) and catch-only (SSS; red broken line; pink shaded 95% CI) estimates of spawning biomass (upper panel) and stock status (lower panel) for rex sole. Darker red shaded area is the overlap of the top models.

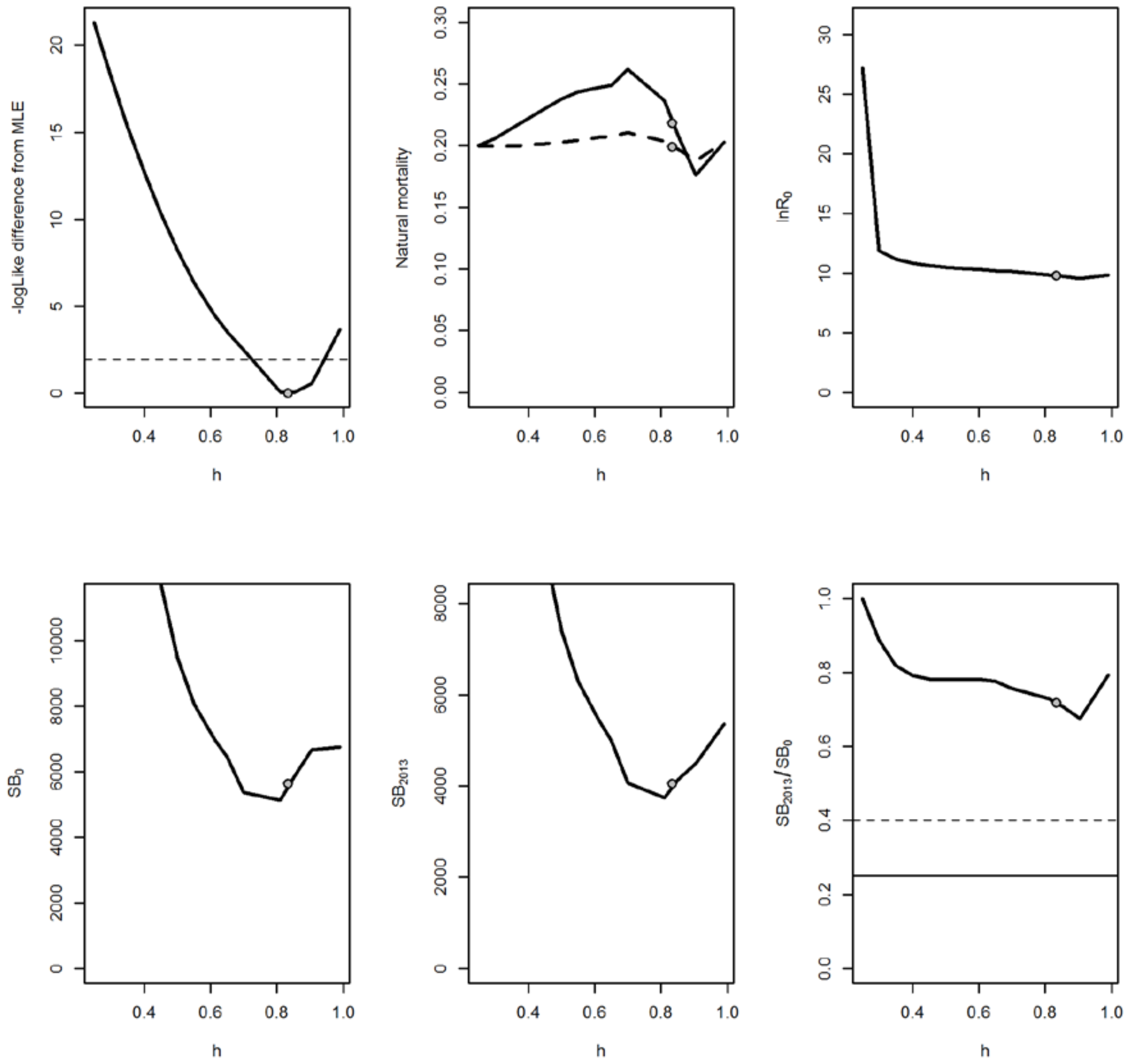

Figure 122. Likelihood profile for steepness (h; top left panel) and sensitivity to h of estimated (top center and right panels) and derived assessment outputs (bottom panels) for rex sole using exSSS. The MLE is indicated by the circle. Top left panel: broken line is 95% interval; Top middle panel: solid and broken lines are the female and male *M* values; Bottom right panel: Solid and broken line are the target and limit biomass reference points.

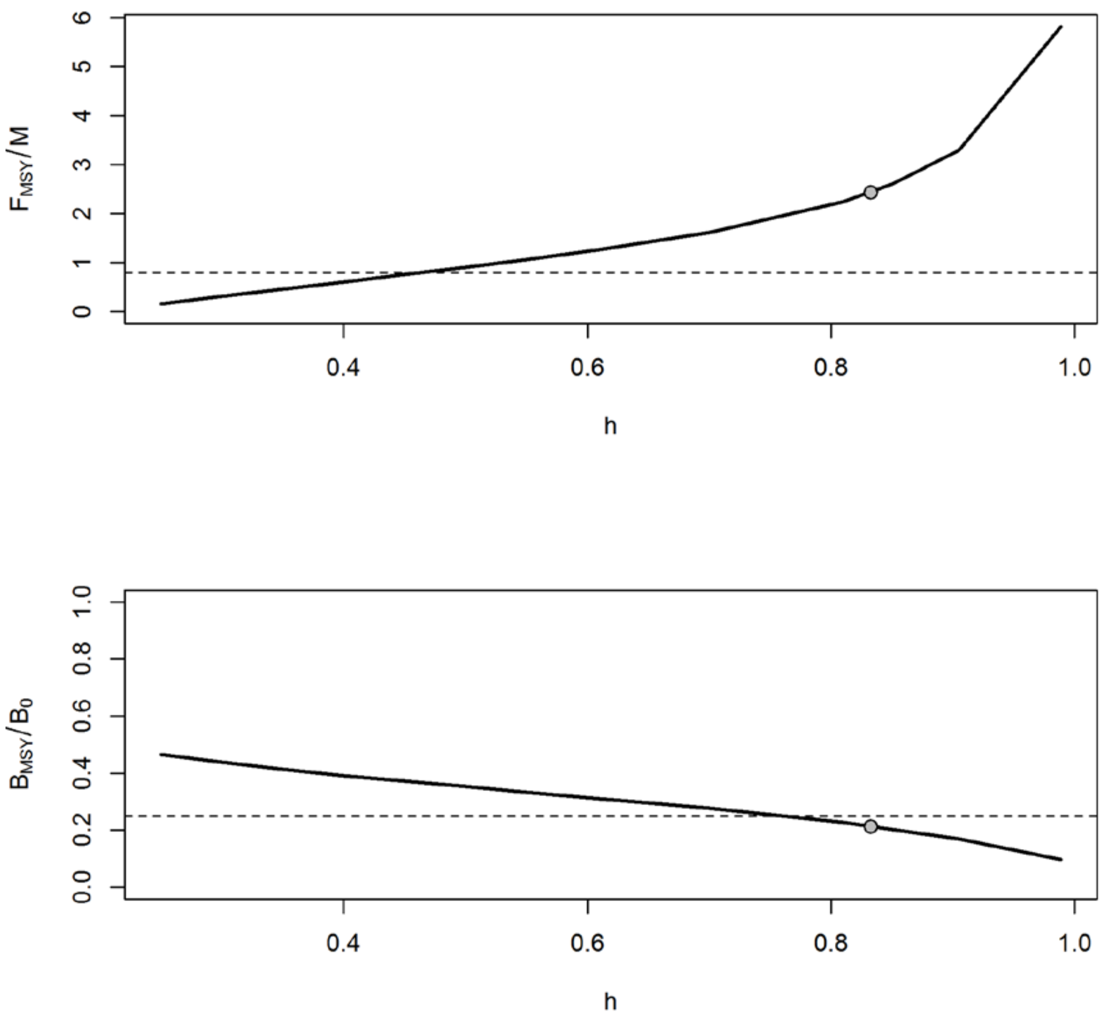

Figure 123. Steepness profile relative to XDB-SRA productivity parameters F_{MSY}/M (top panel) and B_{MSY}/B_0 (bottom panel) for rex sole. Circle indicates exSSS MLE estimate. Broken line is the prior mean used in XDB-SRA.

8.2.8 Stripetail rockfish

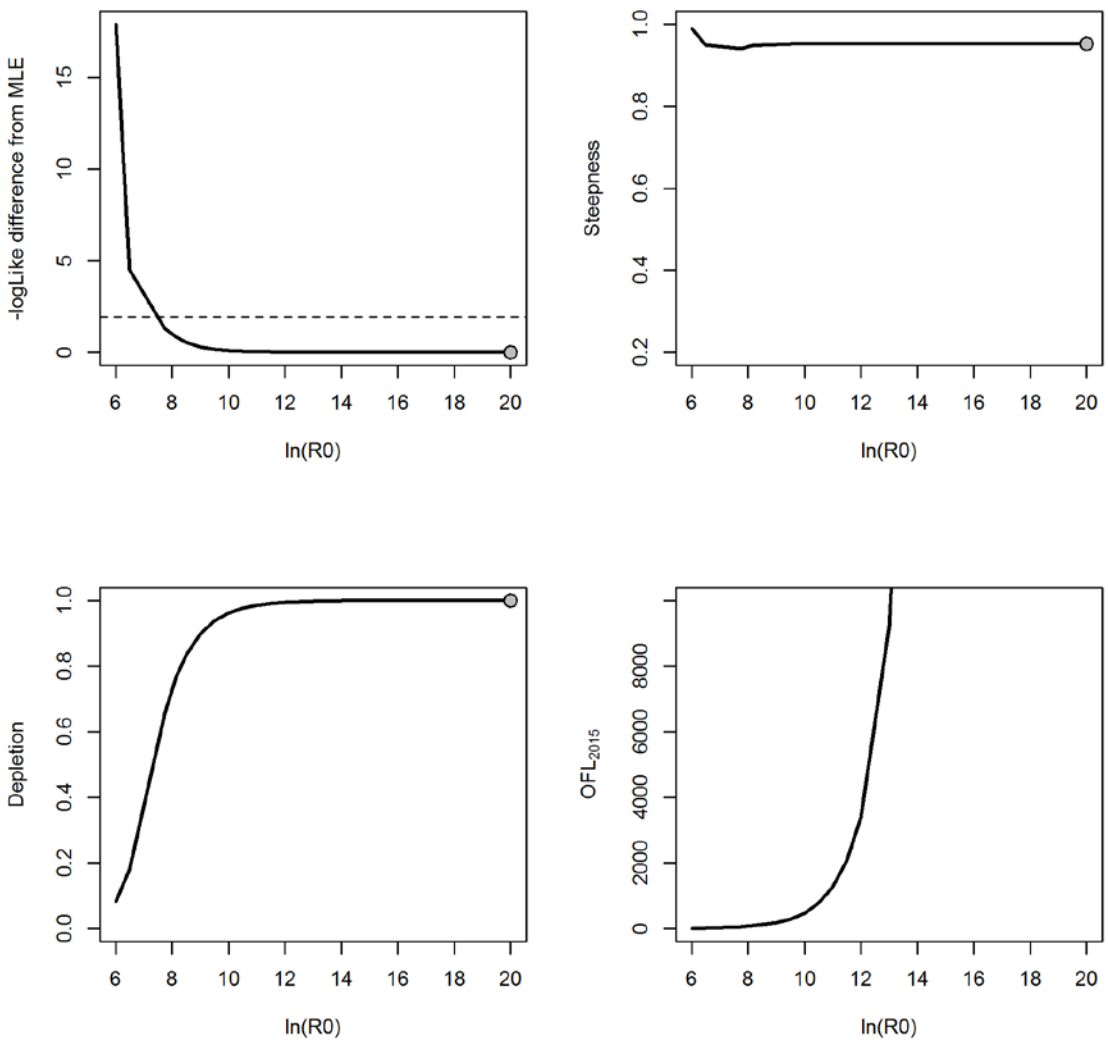

Figure 124. Likelihood, parameter (h), and derived outputs (depletion and OFL_{2015}) profiles over the log of initial recruitment (lnR_0) for the stripetail rockfish.

Appendix

Appendix A. SS Files

Appendix A.1. Sharpchin rockfish

Data file

Global model specifications
1892 # Start year
2012 # End year
1 # Number of seasons/year
12 # Number of months/season
1 # Spawning occurs at beginning of season
1 # Number of fishing fleets
3 # Number of surveys
1 # Number of areas
FISHERY%SURVEY1%SURVEY2%SURVEY3
0.5 0.5 0.5 0.5 # fleet timing_in_season
1 1 1 1 # Area of each fleet
1 # Units for catch by fishing fleet: 1=Biomass(mt),2=Numbers(1000s)
0.01 # SE of log(catch) by fleet for equilibrium and continuous options
2 # Number of genders
58 # Number of ages in population dynamics
Catch section
0 # Initial equilibrium catch (landings + discard) by fishing fleet
121 # Number of lines of catch
Catch Year Season

0.001150487	1892	1
0.001150487	1893	1
0.001150487	1894	1
0.000295835	1895	1
7.12256E-05	1896	1
7.25853E-05	1897	1
4.10928E-05	1898	1
6.94951E-05	1899	1
9.78974E-05	1900	1
0.000126314	1901	1
0.000154716	1902	1
0.000183118	1903	1
0.000211521	1904	1
0.000239937	1905	1
0.000268339	1906	1
0.000296741	1907	1
0.000325157	1908	1
0.00035356	1909	1
0.000381962	1910	1
0.000410364	1911	1
0.000438781	1912	1
0.000467183	1913	1
0.000495585	1914	1
0.000523988	1915	1
0.018731296	1916	1
0.028327536	1917	1
0.033139857	1918	1
0.023600435	1919	1
0.024585622	1920	1
0.019830105	1921	1
0.01794494	1922	1
0.01893014	1923	1
0.010347488	1924	1
0.007505539	1925	1
0.027626414	1926	1
0.043922655	1927	1

0.059811315	1928	1
0.074049115	1929	1
0.067938907	1930	1
0.047493313	1931	1
0.054534866	1932	1
0.083571299	1933	1
0.079491029	1934	1
0.082405376	1935	1
0.074946685	1936	1
0.094108711	1937	1
0.114752532	1938	1
0.161103139	1939	1
0.42489214	1940	1
0.685717911	1941	1
1.043338636	1942	1
3.598970821	1943	1
5.777112792	1944	1
10.6939928	1945	1
7.161619571	1946	1
4.383698696	1947	1
4.512894336	1948	1
5.229668663	1949	1
5.969479224	1950	1
6.06440304	1951	1
10.40211061	1952	1
7.072621356	1953	1
10.36534135	1954	1
7.772092358	1955	1
13.16262469	1956	1
12.29774895	1957	1
11.0445706	1958	1
9.853816807	1959	1
12.63058548	1960	1
14.6787664	1961	1
18.76841144	1962	1
23.87977742	1963	1
21.30568814	1964	1
20.02847431	1965	1
891.6235817	1966	1
510.9169406	1967	1
298.9894879	1968	1
32.96547412	1969	1
46.74018601	1970	1
67.46147099	1971	1
44.82446649	1972	1
70.95380365	1973	1
42.92714017	1974	1
46.2968068	1975	1
36.93121077	1976	1
12.58769187	1977	1
179.9407398	1978	1
187.8498453	1979	1
176.3192986	1980	1
27.70463145	1981	1
25.93266787	1982	1
495.4771827	1983	1
175.7152567	1984	1
635.3283565	1985	1
434.3894091	1986	1
418.4213399	1987	1
867.8299995	1988	1
921.9327553	1989	1
704.3979598	1990	1
455.4709878	1991	1
399.6197281	1992	1
753.0953235	1993	1
830.296212	1994	1
450.7280813	1995	1
426.9589781	1996	1
644.4560797	1997	1

```
199.629736	1998	1
93.84972025	1999	1
18.17774475	2000	1
13.52855594	2001	1
9.518229623	2002	1
8.005632828	2003	1
38.17946805	2004	1
5.748690254	2005	1
0.255711987	2006	1
3.842639735	2007	1
1.839040923	2008	1
2.037965884	2009	1
0.569843338	2010	1
0.783928411	2011	1
13.68731875	2012	1

19 # Number of index observations
# Units: 0=numbers,1=biomass,2=F; Errortype: -1=normal,0=lognormal,>0=T
# Fleet Units Errortype
1 1 0 # fleet 1: FISHERY
2 1 0 # fleet 2: SURVEY
3 1 0 # fleet 2: SURVEY
4 1 0 # fleet 2: SURVEY
#_year seas index obs se(log)
1980	1	2	12581.44	0.462964486	#Tri early
1983	1	2	16110.57	0.374595369
1986	1	2	8634.25	0.580113613
1989	1	2	9519.64	.383331259
1992	1	2	9108.24	0.391341879
1995	1	3	3938.93	0.466238502	#Tri late
1998	1	3	2202.63	0.454324983
2001	1	3	1661.22	0.469075594
2004	1	3	4134.65	0.443822656
2003	1	4	50174.25399	0.471483982	#NWFSC
2004	1	4	117780.528	0.588720526
2005	1	4	68461.82512	0.489966596
2006	1	4	43764.76248	0.539389308
2007	1	4	32385.21202	0.534870966
2008	1	4	36878.05159	0.529974414
2009	1	4	49675.6004	0.464195841
2010	1	4	29165.19996	0.418899015
2011	1	4	53769.16783	0.463277617
2012	1	4	41190.7276	0.457001953

0 #_N_fleets_with_discard
0 #_N_discard_obs
0 #_N_meanbodywt_obs
30 #_DF_meanwt
## Population size structure
1 # length bin method: 1=use databins; 2=generate from binwidth,min,max below; 3=read vector
# binwidth for population size comp
# minimum size in the population (lower edge of first bin and size at age 0.00)
# maximum size in the population (lower edge of last bin)
-1 #_comp_tail_compression
1e-007 #_add_to_comp
0 #_combine males into females at or below this bin number
22 #_N_LengthBins
2	4	6	8	10	12	14	16	18	20	22	24
	26	28	30	32	34	36	38	40 42  44
0 #_N_Length_obs
#Yr Seas Flt/Svy Gender Part Nsamp datavector(female-male)
52 #_N_age_bins
1	2	3	4	5	6	7	8	9	10	11	12
	13	14	15	16	17	18	19	20	21	22	23
	24	25	26	27	28	29	30	31	32	33	34
	35	36	37	38	39	40	41	42	43	44	45
	46	47	48	49	50	51	52
0 #_N_ageerror_definitions
0 #_N_Agecomp_obs
1 #_Lbin_method: 1=poplenbins; 2=datalenbins; 3=lengths
```

0 #_combine males into females at or below this bin number
0 #_N_MeanSize-at-Age_obs
0 #_N_environ_variables
0 #_N_environ_obs
0 # N sizefreq methods to read
0 # no tag data
0 # no morphcomp data

999 # End data file

Control file

#C growth parameters are estimated
1 #_N_Growth_Patterns
1 #_N_Morphs_Within_GrowthPattern
0 #_Nblock_Patterns
#_Cond 0 #_blocks_per_pattern
0.5 #_fracfemale
0 #_natM_type:_0=1Parm; 1=N_breakpoints;_2=Lorenzen;_3=agespecific;_4=agespec_withseasinterpolate
#_no additional input for selected M option; read 1P per morph
1 # GrowthModel: 1=vonBert with L1andL2; 2=Richards with L1andL2; 3=not implemented; 4=not implemented
1 #_Growth_Age_for_L1
999 #_Growth_Age_for_L2 (999 to use as Linf)
0 #_SD_add_to_LAA (set to 0.1 for SS2 V1.x compatibility)
0 #_CV_Growth_Pattern: 0 CV=f(LAA); 1 CV=F(A); 2 SD=F(LAA); 3 SD=F(A)
1 #_maturity_option: 1=length logistic; 2=age logistic; 3=read age-maturity matrix by growth_pattern; 4=read age-fecundity; 5=read fec and wt from wtatage.ss
#_placeholder for empirical age-maturity by growth pattern
0 #_First_Mature_Age
1 #_fecundity option:(1)eggs=Wt*(a+b*Wt);(2)eggs=a*L^b;(3)eggs=a*Wt^b
0 #_hermaphroditism option: 0=none; 1=age-specific fxn
1 #_parameter_offset_approach (1=none, 2= M, G, CV_G as offset from female-GP1, 3=like SS2 V1.x)
2 #_env/block/dev_adjust_method (1=standard; 2=logistic transform keeps in base parm bounds; 3=standard w/ no bound check)
#
#_growth_parms
#_LO HI INIT PRIOR PR_type SD PHASE env-var use_dev dev_minyr dev_maxyr dev_stddev Block Block_Fxn
0.001 2 0.077 -2.564 3 0.4 2 0 0 0 0 0 0 0 # NatM_p_1_Fem_GP_1
1 16.50117351 8.250586756 36 -1 10 -2 0 0 0 0 0 0 0 # L_at_Amin_Fem_GP_1
1 66.42 33.21 70 -1 10 -4 0 0 0 0 0 0 0 # L_at_Amax_Fem_GP_1
0.05 0.34 0.17 0.15 -1 0.8 -4 0 0 0 0 0 0 0 # VonBert_K_Fem_GP_1
0.05 0.2 0.1 0.1 -1 0.8 -3 0 0 0 0 0 0 0 # CV_young_Fem_GP_1
0.05 0.2 0.1 0.1 -1 0.8 -3 0 0 0 0 0 0 0 # CV_old_Fem_GP_1
0.001 2 0.077 -2.564 3 0.4 2 0 0 0 0 0 0 0 # NatM_p_1_Fem_GP_1
1 16.50117351 8.23 36 -1 10 -2 0 0 0 0 0 0 0 # L_at_Amin_Fem_GP_1
1 66.42 26.98 70 -1 10 -4 0 0 0 0 0 0 0 # L_at_Amax_Fem_GP_1
0.05 0.34 0.2 0.15 -1 0.8 -4 0 0 0 0 0 0 0 # VonBert_K_Fem_GP_1
0.05 0.2 0.1 0.1 -1 0.8 -3 0 0 0 0 0 0 0 # CV_young_Fem_GP_1
0.05 0.2 0.1 0.1 -1 0.8 -3 0 0 0 0 0 0 0 # CV_old_Fem_GP_1
-3 3 8.27E-06 2.44E-06 -1 0.8 -3 0 0 0 0 0 0 0 # Wtlen_1_Fem
-3 4 3.16 3.34694 -1 0.8 -3 0 0 0 0 0 0 0 # Wtlen_2_Fem
1 1000 22 55 -1 0.8 -3 0 0 0 0 0 0 0 # Mat50%_Fem
-3 3 -5.01 -0.25 -1 0.8 -3 0 0 0 0 0 0 0 # Mat_slope_Fem
-3 3 1 1 -1 0.8 -3 0 0 0 0 0 0 0 # Eggs/kg_inter_Fem
-3 3 0 0 -1 0.8 -3 0 0 0 0 0 0 0 # Eggs/kg_slope_wt_Fem
-3 3 9.10E-06 2.44E-06 -1 0.8 -3 0 0 0 0 0 0 0 # Wtlen_1_Mal
-3 4 3.13 3.34694 -1 0.8 -3 0 0 0 0 0 0 0 # Wtlen_2_Mal

```
0	0	0	0	-1	0	-4	0	0	0	0	0
	0	0	#	RecrDist_GP_1
0	0	0	0	-1	0	-4	0	0	0	0	0
	0	0	#	RecrDist_Area_1
0	0	0	0	-1	0	-4	0	0	0	0	0
	0	0	#	RecrDist_Seas_1
0	0	0	0	-1	0	-4	0	0	0	0	0
	0	0	#	CohortGrowDev
#_seasonal_effects_on_biology_parms
	0	0	0	0	0	0	0	0	0	0
#_Spawner-Recruitment
3	#_SR_function
#_LO	HI	INIT	PRIOR	PR_type	SD	PHASE
1 31 12.32 12.32 -1 10 1  # SR_R0
0.25 0.99 0.779	0.779  2 0.152 3 # SR_steep
0	2	0.01	0.8	-1	0.8	-4	#	SR_sigmaR
-5	5	0.1	0	-1	1	-3	#	SR_envlink
-5	5	0	0	-1	1	-4	#	SR_R1_offset
0	0	0	0	-1	0	-99	#	SR_autocorr
0	#_SR_env_link
0	#_SR_env_target_0=none;1=devs;_2=R0;_3=steepness
0	#do_recdev:	0=none;	1=devvector;	2=simple	deviations
2010	#first	year	of	main	recr_devs;
2010	#last	year	of	main	recr_devs;
-2	#_recdev	phase
1	#	(0/1)	to	read	13	advanced	options
0	#_recdev_early_start	(0=none)
-4	#_recdev_early_phase
-1	#_forecast_recruitment	phase
1	#_lambda	for	fore_recr_like	occurring	before	endyr+1
1990	#_last_early_yr_nobias_adj_in_MPD
1999	#_first_yr_fullbias_adj_in_MPD
2000	#_last_yr_fullbias_adj_in_MPD
2010	#_first_recent_yr_nobias_adj_in_MPD
1.0	#_max_bias_adj_in_MPD
-5	#min	rec_dev
5	#max	rec_dev
0	#_read_recdevs
#Fishing Mortality info
0.3 # F ballpark for tuning early phases
-2001 # F ballpark year (neg value to disable)
1 # F_Method:  1=Pope; 2=instan. F; 3=hybrid (hybrid is recommended)
0.9 # max F or harvest rate, depends on F_Method
# no additional F input needed for Fmethod 1
# if Fmethod=2; read overall start F value; overall phase; N detailed inputs to read
# if Fmethod=3; read N iterations for tuning for Fmethod 3
#4  # N iterations for tuning F in hybrid method (recommend 3 to 7)
#_initial_F_parms
#_LO HI INIT PRIOR PR_type SD PHASE
 0 1 0 0.01 0 99 -1 # InitF_1FISHERY1
#_Q_setup
 # Q_type options:  <0=mirror, 0=median_float, 1=mean_float, 2=parameter, 3=parm_w_random_dev, 4=parm_w_randwalk,
5=mean_unbiased_float_assign_to_parm
 #_Den-dep  env-var  extra_se  Q_type
 0 0 0 0 # 1 FISHERY1
 #ADDS EXTRA SD TO SURVEYS
  0 0 1 0 # 2 SURVEY1
 0 0 1 0 # 3 SURVEY2
 0 0 1 0 # 4 SURVEY3
#_Cond 0 #_If q has random component, then 0=read one parm for each fleet with random q; 1=read a parm for each year of index
#_Q_parms(if_any)
# LO HI INIT PRIOR PR_type SD PHASE
 0 5 0.01 0.01 0 99 1 # InitF_1FISHERY1
 0 5 0.01 0.01 0 99 1 # InitF_1FISHERY1
 0 5 0.01 0.01 0 99 1 # InitF_1FISHERY1
#_size_selex_types
#_Pattern Discard Male Special
 1 0 0 0 # 1 FISHERY1
 1 0 0 0 # 2 SURVEY1
 1 0 0 0 # 2 SURVEY2
```

 1 0 0 0 # 2 SURVEY3
#_age_selex_types
#_Pattern ___ Male Special
 10 0 0 0 # 1 FISHERY1
 10 0 0 0 # 2 SURVEY1
 10 0 0 0 # 2 SURVEY2
 10 0 0 0 # 2 SURVEY3
#_LO HI INIT PRIOR PR_type SD PHASE env-var use_dev dev_minyr dev_maxyr dev_stddev Block Block_Fxn
 0 40 22 6 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_1P_1_FISHERY1
 0 60 0.5877124 6 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_1P_2_FISHERY1
 0 40 22 6 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_2P_1_SURVEY1
 0 60 0.5877124 6 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_2P_2_SURVEY1
 0 40 22 6 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_1P_1_FISHERY1
 0 60 0.5877124 6 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_1P_2_FISHERY1
 0 40 22 6 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_2P_1_SURVEY1
 0 60 0.5877124 6 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_2P_2_SURVEY1
Tag loss and Tag reporting parameters go next
0 # TG_custom: 0=no read; 1=read if tags exist
0 #_Variance_adjustments_to_input_values
1 #_maxlambdaphase
1 #_sd_offset
#
0 # number of changes to make to default Lambdas (default value is 1.0)
15=Tag-comp; 16=Tag-negbin
0 # (0/1) read specs for more stddev reporting

999

Starter file

#C starter comment here
SHRP_data.ss
SHRP_control.ss
0 # 0=use init values in control file; 1=use ss3.par
0 # run display detail (0,1,2)
0 # detailed age-structured reports in REPORT.SSO (0,1)
1 # write detailed checkup.sso file (0,1)
4 # write parm values to ParmTrace.sso (0=no,1=good,active; 2=good,all; 3=every_iter,all_parms; 4=every,active)
1 # write to cumreport.sso (0=no,1=likeandtimeseries; 2=add survey fits)
1 # Include prior_like for non-estimated parameters (0,1)
1 # Use Soft Boundaries to aid convergence (0,1) (recommended)
1 # Number of bootstrap datafiles to produce
6 # Turn off estimation for parameters entering after this phase
1 # MCeval burn interval
1 # MCeval thin interval
0.1 # jitter initial parm value by this fraction
-1 # min yr for sdreport outputs (-1 for styr)
-2 # max yr for sdreport outputs (-1 for endyr; -2 for endyr+Nforecastyrs
0 # N individual STD years
#vector of year values
0.0001 # final convergence criteria (e.g., 1.0e-04)
0 # retrospective year relative to end year (e.g., -4)
0 # min age for calc of summary biomass
1 # Depletion basis: denom is: 0=skip; 1=rel X*B0; 2=rel X*Bmsy; 3=rel X*B_styr
1 # Fraction (X) for Depletion denominator (e.g., 0.4)
1 # SPR_report_basis: 0=skip; 1=(1-SPR)/(1-SPR_tgt); 2=(1-SPR)/(1-SPR_MSY); 3=(1-SPR)/(1-SPR_Btarget); 4=rawSPR
3 # F_report_units: 0=skip; 1=exploitation(Bio); 2=exploitation(Num); 3=sum(Frates)
0 # F_report_basis: 0=raw; 1=F/Fspr; 2=F/Fmsy ; 3=F/Fbtgt
999 # check value for end of file

Forecast file

1 # Benchmarks: 0=skip; 1=calc F_spr,F_btgt,F_msy
2 # MSY: 1= set to F(SPR); 2=calc F(MSY); 3=set to F(Btgt); 4=set to F(endyr)
0.5 # SPR target (e.g., 0.40)
0.4 # Biomass target (e.g., 0.40)
#_Bmark_years: beg_bio, end_bio, beg_selex, end_selex, beg_relF, end_relF (enter actual year, or values of 0 or -integer to be rel. endyr)
 0 0 0 0 0 0
2010 2010 2010 2010 2010 2010 # after processing

```
1 #Bmark_relF_Basis: 1 = use year range; 2 = set relF same as forecast below
#
1 # Forecast: 0=none; 1=F(SPR); 2=F(MSY) 3=F(Btgt); 4=Ave F (uses first-last relF yrs); 5=input annual F scalar
12 # N forecast years
0.2 # F scalar (only used for Do_Forecast==5)
#_Fcast_years:  beg_selex, end_selex, beg_relF, end_relF  (enter actual year, or values of 0 or -integer to be rel. endyr)
 0 0 0 0
#  2010 2010 2010 2010 # after processing
1 # Control rule method (1=catch=f(SSB) west coast; 2=F=f(SSB) )
0.4 # Control rule Biomass level for constant F (as frac of Bzero, e.g., 0.40); (Must be > the no F level below)
0.1 # Control rule Biomass level for no F (as frac of Bzero, e.g., 0.10)
1 # Control rule target as fraction of Flimit (e.g., 0.75)
3 #_N forecast loops (1=OFL only; 2=ABC; 3=get F from forecast ABC catch with allocations applied)
3 #_First forecast loop with stochastic recruitment
0 #_Forecast loop control #3 (reserved for future bellsandwhistles)
0 #_Forecast loop control #4 (reserved for future bellsandwhistles)
0 #_Forecast loop control #5 (reserved for future bellsandwhistles)
2013  #FirstYear for caps and allocations (should be after years with fixed inputs)
0 # stddev of log(realized catch/target catch) in forecast (set value>0.0 to cause active impl_error)
0 # Do West Coast gfish rebuilder output (0/1)
2013 # Rebuilder:  first year catch could have been set to zero (Ydecl)(-1 to set to 1999)
2013 # Rebuilder:  year for current age structure (Yinit) (-1 to set to endyear+1)
1 # fleet relative F:  1=use first-last alloc year; 2=read seas(row) x fleet(col) below
# Note that fleet allocation is used directly as average F if Do_Forecast=4
2 # basis for fcast catch tuning and for fcast catch caps and allocation  (2=deadbio; 3=retainbio; 5=deadnum; 6=retainnum)
# Conditional input if relative F choice = 2
# Fleet relative F:  rows are seasons, columns are fleets
#_Fleet:  FISHERY
#  1
# max totalcatch by fleet (-1 to have no max) must enter value for each fleet
 -1
# max totalcatch by area (-1 to have no max); must enter value for each fleet
 -1
# fleet assignment to allocation group (enter group ID# for each fleet, 0 for not included in an alloc group)
 0
#_Conditional on >1 allocation group
# allocation fraction for each of: 0 allocation groups
# no allocation groups
2 # Number of forecast catch levels to input (else calc catch from forecast F)
2 # basis for input Fcast catch:  2=dead catch; 3=retained catch; 99=input Hrate(F) (units are from fleetunits; note new codes in
SSV3.20)
# Input fixed catch values
#Year Seas Fleet Catch(or_F)
 2013 1 1 5
 2014 1 1 5
999 # verify end of input
```

Appendix A.2. Stripetail rockfish

<u>Data file</u>

```
# Data-mod 2013: STRIPETAIL ROCKFISH
#######################################

### Global model specifications ###
1916        # Start year
2012        # End year
1           # Number of seasons/year
12          # Number of months/season
1           # Spawning occurs at beginning of season
1           # Number of fishing fleets
3           # Number of surveys
1           # Number of areas
FISHERY%SURVEY1%SURVEY2%SURVEY3
0.5 0.5 0.5 0.5 # fleet timing_in_season
1 1 1 1     # Area of each fleet
1           # Units for catch by fishing fleet: 1=Biomass(mt),2=Numbers(1000s)
0.01        # SE of log(catch) by fleet for equilibrium and continuous options
2           # Number of genders
```

```
38		# Number of ages in population dynamics

### Catch section ###
0  # Initial equilibrium catch (landings + discard) by fishing fleet
97 # Number of lines of catch
# Catch Year Season
7.847766604	1916	1.0
12.456103 1917	1.0
12.80956601	1918	1.0
8.266706276	1919	1.0
8.686200835	1920	1.0
7.380551764	1921	1.0
6.789597127	1922	1.0
8.237297266	1923	1.0
8.379348333	1924	1.0
9.514647101	1925	1.0
12.79846827	1926	1.0
10.76536236	1927	1.0
10.55616997	1928	1.0
10.3885941	1929	1.0
11.76471382	1930	1.0
13.58807244	1931	1.0
8.752232386	1932	1.0
7.277342785	1933	1.0
7.324508178	1934	1.0
8.336622036	1935	1.0
5.668170533	1936	1.0
5.512247291	1937	1.0
5.593815678	1938	1.0
6.803469301	1939	1.0
5.749184033	1940	1.0
5.260328601	1941	1.0
2.065642938	1942	1.0
3.337699465	1943	1.0
8.631083629	1944	1.0
19.21718604	1945	1.0
18.56421431	1946	1.0
12.22990543	1947	1.0
13.74930192	1948	1.0
23.25609657	1949	1.0
26.23633748	1950	1.0
33.07604198	1951	1.0
27.38090045	1952	1.0
28.99024601	1953	1.0
38.71015752	1954	1.0
30.0156969	1955	1.0
48.31658404	1956	1.0
31.34772024	1957	1.0
29.8459613	1958	1.0
28.03771825	1959	1.0
25.9885719	1960	1.0
22.61220825	1961	1.0
23.16546876	1962	1.0
21.04204611	1963	1.0
21.63261218	1964	1.0
28.0481662	1965	1.0
96.65922143	1966	1.0
73.82546581	1967	1.0
138.7526111	1968	1.0
44.84362734	1969	1.0
54.67133211	1970	1.0
67.43755787	1971	1.0
86.75330593	1972	1.0
280.6180397	1973	1.0
109.5771777	1974	1.0
138.7935032	1975	1.0
112.3771617	1976	1.0
49.1044079	1977	1.0
25.10433712	1978	1.0
64.29779351	1979	1.0
```

67.46562469	1980	1.0
35.85402242	1981	1.0
43.14357267	1982	1.0
38.81323472	1983	1.0
32.27999532	1984	1.0
56.54742267	1985	1.0
23.06332257	1986	1.0
32.85374848	1987	1.0
26.67619172	1988	1.0
33.80815411	1989	1.0
40.70539926	1990	1.0
71.05272323	1991	1.0
13.90491292	1992	1.0
58.82190442	1993	1.0
140.6083616	1994	1.0
67.24009485	1995	1.0
26.09522504	1996	1.0
38.04471623	1997	1.0
62.49803068	1998	1.0
33.45080689	1999	1.0
9.046322481	2000	1.0
19.39662938	2001	1.0
6.820115913	2002	1.0
2.91093711	2003	1.0
3.401457207	2004	1.0
6.33403491	2005	1.0
7.256257079	2006	1.0
8.217321325	2007	1.0
8.632931679	2008	1.0
3.186161056	2009	1.0
1.840005234	2010	1.0
3.829829956	2011	1.0
4.447974053	2012	1.0

19 # Number of index observations
Units: 0=numbers,1=biomass,2=F; Errortype: -1=normal,0=lognormal,>0=T
Fleet Units Errortype
1 1 0 # fleet 1: FISHERY
2 1 0 # fleet 2: SURVEY
3 1 0 # fleet 2: SURVEY
4 1 0 # fleet 2: SURVEY
#_year seas index obs se(log)

1980	1	2	33905.75504	0.453700587	#Tri early
1983	1	2	9706.640967	0.356672026	
1986	1	2	17385.84379	0.519155707	
1989	1	2	14952.04043	0.348535244	
1992	1	2	13745.82105	0.425539977	
1995	1	3	26131.66829	0.322089713	#Tri late
1998	1	3	11470.86613	0.348359624	
2001	1	3	14829.49377	0.336314855	
2004	1	3	25580.18414	0.327940167	
2003	1	4	105706.2531	0.481786923	#NWFSC
2004	1	4	20414.05685	0.506490324	
2005	1	4	13061.25477	0.497711948	
2006	1	4	15287.43463	0.960875857	
2007	1	4	10176.49856	0.593407839	
2008	1	4	33992.37007	0.92573315	
2009	1	4	3452.444848	0.619567676	
2010	1	4	3540.323855	0.505577251	
2011	1	4	17191.3474	0.48520558	
2012	1	4	18650.79603	0.553209108	

0 #_N_fleets_with_discard
0 #_N_discard_obs

0 #_N_meanbodywt_obs
30 #_DF_meanwt

Population size structure
1 # length bin method: 1=use databins; 2=generate from binwidth,min,max below; 3=read vector

```
# binwidth for population size comp
# minimum size in the population (lower edge of first bin and size at age 0.00)
# maximum size in the population (lower edge of last bin)
-1 #_comp_tail_compression
1e-007 #_add_to_comp
0 #_combine males into females at or below this bin number
20 #_N_LengthBins
2 4 6 8 10 12 14 16 18 20 22 24
  26 28 30 32 34 36 38 40
0 #_N_Length_obs
#Yr Seas Flt/Svy Gender Part Nsamp datavector(female-male)
34 #_N_age_bins
1 2 3 4 5 6 7 8 9 10 11 12
  13 14 15 16 17 18 19 20 21 22 23
  24 25 26 27 28 29 30 31 32 33 34
0 #_N_ageerror_definitions
0 #_N_Agecomp_obs
1 #_Lbin_method: 1=poplenbins; 2=datalenbins; 3=lengths
0 #_combine males into females at or below this bin number
0 #_N_MeanSize-at-Age_obs
0 #_N_environ_variables
0 #_N_environ_obs
0 # N sizefreq methods to read
0 # no tag data
0 # no morphcomp data
999 # End data file
```

Control file

```
#C growth parameters are estimated
1  #_N_Growth_Patterns
1 #_N_Morphs_Within_GrowthPattern
0 #_Nblock_Patterns
#_Cond 0 #_blocks_per_pattern
# begin and end years of blocks
#
0.5 #_fracfemale
0 #_natM_type:_0=1Parm; 1=N_breakpoints;_2=Lorenzen;_3=agespecific;_4=agespec_withseasinterpolate
  #_no additional input for selected M option; read 1P per morph
1 # GrowthModel: 1=vonBert with L1andL2; 2=Richards with L1andL2; 3=not implemented; 4=not implemented
1 #_Growth_Age_for_L1
999 #_Growth_Age_for_L2 (999 to use as Linf)
0 #_SD_add_to_LAA (set to 0.1 for SS2 V1.x compatibility)
0 #_CV_Growth_Pattern
1 #_maturity_option: 1=length logistic
4 #_First_Mature_Age
1 #_fecundity option:(1)eggs=Wt*(a+b*Wt);(2)eggs=a*L^b;(3)eggs=a*Wt^b
0 #_hermaphroditism option: 0=none; 1=age-specific fxn
1 #_parameter_offset_approach (1=none, 2= M, G, CV_G as offset from female-GP1, 3=like SS2 V1.x)
2 #_env/block/dev_adjust_method (1=standard; 2=logistic transform keeps in base parm
  bounds; 3=standardw/ no bound check)
#
#_growth_parms
#_LO HI INIT PRIOR PR_type SD PHASE env-var use_dev dev_minyr dev_maxyr
  dev_stddev Block Block_Fxn
0.001 2 0.121 -2.112 3 0.4 1 0 0 0 0 0 0 0 # NatM_p_1_Fem_GP_1
1 18.94836209 9.474181043 36 -1 10 -2 0 0 0 0 0 0 0 # L_at_Amin_Fem_GP_1
1 66.1 33.05 70 -1 10 -4 0 0 0 0 0 0 0 # L_at_Amax_Fem_GP_1
0.05 0.12 0.06 0.15 -1 0.8 -4 0 0 0 0 0 0 0 # VonBert_K_Fem_GP_1
0.05 0.2 0.1 0.1 -1 0.8 -3 0 0 0 0 0
  0 0 # CV_young_Fem_GP_1
0.05 0.2 0.1 0.1 -1 0.8 -3 0 0 0 0 0
  0 0 # CV_old_Fem_GP_1
0.001 2 0.121 -2.112 3 0.4 2 0 0 0 0 0 0 0 # NatM_p_1_Mal_GP_1
1 18.94836209 10.37 36 -1 10 -2 0 0 0 0 0 0 0 # L_at_Amin_Mal_GP_1
1 66.1 17.38 70 -1 10 -4 0 0 0 0 0 0 0 # L_at_Amax_Mal_GP_1
0.05 0.12 0.019 0.15 -1 0.8 -4 0 0 0 0 0 0 0 # VonBert_K_Mal_GP_1
0.05 0.2 0.1 0.1 -1 0.8 -3 0 0 0 0 0
  0 0 # CV_young_Mal_GP_1
```

```
0.05	0.2	0.1	0.1	-1	0.8	-3	0	0	0	0	0
	0	0	#	CV_old_Mal_GP_1
-3	3	1.68E-05	2.44E-06	-1	0.8	-3	0	0	0	0	0
	0	0	#	Wtlen_1_Fem
-3	4	2.95	3.34694	-1	0.8	-3	0	0	0	0	0
	0	0	#	Wtlen_2_Fem
1 1000 17  3 -1 0.8 -3 0 0 0 0 0 0 0 # Mat50%_Fem
-30	3	-2.30	-0.25	-1	0.8	-3	0	0	0	0	0
	0	0	#	Mat_slope_Fem
-3	3	1	1	-1	0.8	-3	0	0	0	0	0
	0	0	#	Eggs/kg_inter_Fem
-3	3	0	0	-1	0.8	-3	0	0	0	0	0
	0	0	#	Eggs/kg_slope_wt_Fem
-3	3	2.98E-05	2.44E-06	-1	0.8	-3	0	0	0	0	0
	0	0	#	Wtlen_1_Mal
-3	4	2.72	3.34694	-1	0.8	-3	0	0	0	0	0
	0	0	#	Wtlen_2_Mal
0	0	0	0	-1	0	-4	0	0	0	0	0
	0	0	#	RecrDist_GP_1
0	0	0	0	-1	0	-4	0	0	0	0	0
	0	0	#	RecrDist_Area_1
0	0	0	0	-1	0	-4	0	0	0	0	0
	0	0	#	RecrDist_Seas_1
0	0	0	0	-1	0	-4	0	0	0	0	0
	0	0	#	CohortGrowDev
#
#_seasonal_effects_on_biology_parms
	0	0	0	0	0	0	0	0	0	0#_Spawner-
Recruitment
3	#_SR_function
#_LO	HI	INIT	PRIOR	PR_type	SD	PHASE
1 31  10  2.3  -1 3 1  #-1 10 1  # SR_R0
0.25 0.99 0.4	0.779  2 0.152 3 # SR_steep # SR_steep
0	2	0.01	0.8	-1	0.8	-4	#	SR_sigmaR
-5	5	0.1	0	-1	1	-3	#	SR_envlink
-5	5	0	0	-1	1	-4	#	SR_R1_offset
0	0	0	0	-1	0	-99	#	SR_autocorr
0	#_SR_env_link
0	#_SR_env_target_0=none;1=devs;_2=R0;_3=steepness
0	#do_recdev:	0=none;	1=devvector;	2=simple	deviations
2012	#	first	year	of	main	recr_devs
2012	#	last	year	of	main	recr_devs
-2	#_recdev	phase
1	#	(0/1)	to	read	13	advanced	options
0	#_recdev_early_start	(0=none;	neg	value	makes	relative	to	recdev_start)
-4	#_recdev_early_phase
-1	#_forecast_recruitment
1	#_lambda	for	fore_recr_like	occurring	before	endyr+1
1990	#_last_early_yr_nobias_adj_in_MPD
1999	#_first_yr_fullbias_adj_in_MPD
2000	#_last_yr_fullbias_adj_in_MPD
2012	#_first_recent_yr_nobias_adj_in_MPD
1.0	#_max_bias_adj_in_MPD
0	#_period	of	cycles	in	recruitment	(N	parms	read	below)
-5	#min	rec_dev
5	#max	rec_dev
0	#_read_recdevs
#Fishing Mortality info
0.3 # F ballpark for tuning early phases
-2001 # F ballpark year (neg value to disable)
1 # F_Method:  1=Pope; 2=instan. F; 3=hybrid (hybrid is recommended)
0.9 # max F or harvest rate, depends on F_Method
#_initial_F_parms
#_LO HI INIT PRIOR PR_type SD PHASE
 0 1 0 0.01 0 99 -1 # InitF_1FISHERY1
#_Q_setup
 # Q_type options:  <0=mirror, 0=median_float, 1=mean_float, 2=parameter, 3=parm_w_random_dev, 4=parm_w_randwalk,
5=mean_unbiased_float_assign_to_parm
 #_Den-dep  env-var  extra_se  Q_type
 0 0 0 0 # 1 FISHERY1
```

ADDS EXTRA SD TO SURVEYS
0 0 1 0 # 2 SURVEY1
 0 0 1 0 # 3 SURVEY2
 0 0 1 0 # 4 SURVEY3
#
#_Cond 0 #_If q has random component, then 0=read one parm for each fleet with random q; 1=read a parm for each year of index
#_Q_parms(if_any)
LO HI INIT PRIOR PR_type SD PHASE
0 5 0.01 0.01 0 99 1 # InitF_1FISHERY1
0 5 0.01 0.01 0 99 1 # InitF_1FISHERY1
0 5 0.01 0.01 0 99 1 # InitF_1FISHERY1
#_size_selex_types
#_Pattern Discard Male Special
 1 0 0 0 # 1 FISHERY1
 1 0 0 0 # 2 SURVEY1
 1 0 0 0 # 2 SURVEY1
 1 0 0 0 # 2 SURVEY1
#
#_age_selex_types
#_Pattern ___ Male Special
 10 0 0 0 # 1 FISHERY1
 10 0 0 0 # 2 SURVEY1
 10 0 0 0 # 2 SURVEY1
 10 0 0 0 # 2 SURVEY1
#_LO HI INIT PRIOR PR_type SD PHASE env-var use_dev dev_minyr dev_maxyr dev_stddev Block Block_Fxn
 0 40 17 4 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_1P_1_FISHERY1
 0 40 1.280191 38 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_1P_2_FISHERY1
 0 40 17 4 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_1P_1_FISHERY1
 0 40 1.280191 38 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_1P_2_FISHERY1
 0 40 17 4 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_1P_1_FISHERY1
 0 40 1.280191 38 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_1P_2_FISHERY1
 0 40 17 4 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_1P_1_FISHERY1
 0 40 1.280191 38 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_1P_2_FISHERY1
Tag loss and Tag reporting parameters go next
0 # TG_custom: 0=no read; 1=read if tags exist
#_Cond -6 6 1 1 2 0.01 -4 0 0 0 0 0 0 0 #_placeholder if no parameters
#
0 #_Variance_adjustments_to_input_values
1 #_maxlambdaphase
1 #_sd_offset
#
0 # number of changes to make to default Lambdas (default value is 1.0)
0 # (0/1) read specs for more stddev reporting

999

Starter file
#C starter comment here
STRK_data.ss
STRK_control.ctl
0 # 0=use init values in control file; 1=use ss3.par
0 # run display detail (0,1,2)
0 # detailed age-structured reports in REPORT.SSO (0,1)
1 # write detailed checkup.sso file (0,1)
4 # write parm values to ParmTrace.sso (0=no,1=good,active; 2=good,all; 3=every_iter,all_parms; 4=every,active)
1 # write to cumreport.sso (0=no,1=likeandtimeseries; 2=add survey fits)
1 # Include prior_like for non-estimated parameters (0,1)
1 # Use Soft Boundaries to aid convergence (0,1) (recommended)
1 # Number of bootstrap datafiles to produce
6 # Turn off estimation for parameters entering after this phase
1 # MCeval burn interval
1 # MCeval thin interval
0.1 # jitter initial parm value by this fraction
-1 # min yr for sdreport outputs (-1 for styr)
-2 # max yr for sdreport outputs (-1 for endyr; -2 for endyr+Nforecastyrs
0 # N individual STD years
#vector of year values
0.0001 # final convergence criteria (e.g., 1.0e-04)
0 # retrospective year relative to end year (e.g., -4)

0 # min age for calc of summary biomass
1 # Depletion basis: denom is: 0=skip; 1=rel X*B0; 2=rel X*Bmsy; 3=rel X*B_styr
1 # Fraction (X) for Depletion denominator (e.g., 0.4)
1 # SPR_report_basis: 0=skip; 1=(1-SPR)/(1-SPR_tgt); 2=(1-SPR)/(1-SPR_MSY); 3=(1-SPR)/(1-SPR_Btarget); 4=rawSPR
3 # F_report_units: 0=skip; 1=exploitation(Bio); 2=exploitation(Num); 3=sum(Frates)
2 # F_report_basis: 0=raw; 1=F/Fspr; 2=F/Fmsy ; 3=F/Fbtgt
999 # check value for end of file

Forecast file

1 # Benchmarks: 0=skip; 1=calc F_spr,F_btgt,F_msy
2 # MSY: 1= set to F(SPR); 2=calc F(MSY); 3=set to F(Btgt); 4=set to F(endyr)
0.5 # SPR target (e.g., 0.40)
0.4 # Biomass target (e.g., 0.40)
#_Bmark_years: beg_bio, end_bio, beg_selex, end_selex, beg_relF, end_relF (enter actual year, or values of 0 or -integer to be rel. endyr)
 0 0 0 0 0 0
2010 2010 2010 2010 2010 2010 # after processing
1 #Bmark_relF_Basis: 1 = use year range; 2 = set relF same as forecast below
#
1 # Forecast: 0=none; 1=F(SPR); 2=F(MSY) 3=F(Btgt); 4=Ave F (uses first-last relF yrs); 5=input annual F scalar
12 # N forecast years
0.2 # F scalar (only used for Do_Forecast==5)
#_Fcast_years: beg_selex, end_selex, beg_relF, end_relF (enter actual year, or values of 0 or -integer to be rel. endyr)
 0 0 0 0
2010 2010 2010 2010 # after processing
1 # Control rule method (1=catch=f(SSB) west coast; 2=F=f(SSB))
0.4 # Control rule Biomass level for constant F (as frac of Bzero, e.g., 0.40); (Must be > the no F level below)
0.1 # Control rule Biomass level for no F (as frac of Bzero, e.g., 0.10)
1 # Control rule target as fraction of Flimit (e.g., 0.75)
3 #_N forecast loops (1=OFL only; 2=ABC; 3=get F from forecast ABC catch with allocations applied)
3 #_First forecast loop with stochastic recruitment
0 #_Forecast loop control #3 (reserved for future bellsandwhistles)
0 #_Forecast loop control #4 (reserved for future bellsandwhistles)
0 #_Forecast loop control #5 (reserved for future bellsandwhistles)
2013 #FirstYear for caps and allocations (should be after years with fixed inputs)
0 # stddev of log(realized catch/target catch) in forecast (set value>0.0 to cause active impl_error)
0 # Do West Coast gfish rebuilder output (0/1)
2013 # Rebuilder: first year catch could have been set to zero (Ydecl)(-1 to set to 1999)
2013 # Rebuilder: year for current age structure (Yinit) (-1 to set to endyear+1)
1 # fleet relative F: 1=use first-last alloc year; 2=read seas(row) x fleet(col) below
Note that fleet allocation is used directly as average F if Do_Forecast=4
2 # basis for fcast catch tuning and for fcast catch caps and allocation (2=deadbio; 3=retainbio; 5=deadnum; 6=retainnum)
Conditional input if relative F choice = 2
Fleet relative F: rows are seasons, columns are fleets
#_Fleet: FISHERY
1
max totalcatch by fleet (-1 to have no max) must enter value for each fleet
 -1
max totalcatch by area (-1 to have no max); must enter value for each fleet
 -1
fleet assignment to allocation group (enter group ID# for each fleet, 0 for not included in an alloc group)
 0
#_Conditional on >1 allocation group
allocation fraction for each of: 0 allocation groups
no allocation groups
2 # Number of forecast catch levels to input (else calc catch from forecast F)
2 # basis for input Fcast catch: 2=dead catch; 3=retained catch; 99=input Hrate(F) (units are from fleetunits; note new codes in SSV3.20)
Input fixed catch values
#Year Seas Fleet Catch(or_F)
 2013 1 1 3.4
 2014 1 1 3.4
999 # verify end of input

Appendix A.3. Yellowtail rockfish (North of 40° 10′ N lat.)

Data file

Data-mod 2013: YELLOWTAIL NORTH ROCKFISH

```
########################################

### Global model specifications ###
1892        # Start year
2012        # End year
1           # Number of seasons/year
12          # Number of months/season
1           # Spawning occurs at beginning of season
1           # Number of fishing fleets
2           # Number of surveys
1           # Number of areas
FISHERY%Triennial%NWFSC
0.5 0.5 0.5 # fleet timing_in_season
1 1 1       # Area of each fleet
1           # Units for catch by fishing fleet: 1=Biomass(mt),2=Numbers(1000s)
0.01        # SE of log(catch) by fleet for equilibrium and continuous options
2           # Number of genders
64          # Number of ages in population dynamics

### Catch section ###
0  # Initial equilibrium catch (landings + discard) by fishing fleet
121 # Number of lines of catch
# Catch Year Season
2.179923641     1892    1.0
2.179923641     1893    1.0
2.179923641     1894    1.0
0.560555063     1895    1.0
0.134944203     1896    1.0
0.137546252     1897    1.0
0.077851691     1898    1.0
0.131677636     1899    1.0
0.185503581     1900    1.0
0.239319989     1901    1.0
0.293145934     1902    1.0
0.346971879     1903    1.0
0.400797824     1904    1.0
0.454614232     1905    1.0
0.508440177     1906    1.0
0.562266122     1907    1.0
0.61608253      1908    1.0
0.669908475     1909    1.0
0.72373442      1910    1.0
0.777560365     1911    1.0
0.831376773     1912    1.0
0.885202718     1913    1.0
0.939028663     1914    1.0
0.992854608     1915    1.0
3.035198871     1916    1.0
5.013428734     1917    1.0
10.2907837      1918    1.0
3.307769605     1919    1.0
4.113251535     1920    1.0
5.592206255     1921    1.0
4.556611093     1922    1.0
2.467933617     1923    1.0
4.333689409     1924    1.0
10.79270794     1925    1.0
10.72067684     1926    1.0
18.97511125     1927    1.0
17.70551093     1928    1.0
26.02660946     1929    1.0
36.91904695     1930    1.0
41.93393506     1931    1.0
27.92354337     1932    1.0
25.96381366     1933    1.0
22.91444839     1934    1.0
34.89300721     1935    1.0
40.0264671      1936    1.0
48.18266148     1937    1.0
55.26373671     1938    1.0
```

62.69846195	1939	1.0
140.3158232	1940	1.0
188.6193066	1941	1.0
341.3979187	1942	1.0
1116.685285	1943	1.0
1936.512538	1944	1.0
3390.804562	1945	1.0
2201.014236	1946	1.0
1208.997327	1947	1.0
1076.03877	1948	1.0
951.8411821	1949	1.0
961.3926344	1950	1.0
855.0280503	1951	1.0
1008.617746	1952	1.0
796.0048183	1953	1.0
1147.37031	1954	1.0
975.5500468	1955	1.0
1475.458455	1956	1.0
1610.51716	1957	1.0
1434.977317	1958	1.0
1588.919666	1959	1.0
1994.718096	1960	1.0
1963.126365	1961	1.0
2447.958202	1962	1.0
1900.84491	1963	1.0
1598.463435	1964	1.0
1573.934988	1965	1.0
4896.570072	1966	1.0
3016.479951	1967	1.0
3321.470042	1968	1.0
3821.105623	1969	1.0
2215.580474	1970	1.0
1674.707728	1971	1.0
2533.196617	1972	1.0
2347.888846	1973	1.0
1702.736483	1974	1.0
1428.225223	1975	1.0
4324.366471	1976	1.0
5086.99836	1977	1.0
8282.488631	1978	1.0
8047.547628	1979	1.0
7889.58503	1980	1.0
9298.114289	1981	1.0
9799.270236	1982	1.0
8931.041533	1983	1.0
5521.196029	1984	1.0
3769.608425	1985	1.0
5397.855277	1986	1.0
5268.109663	1987	1.0
6956.758651	1988	1.0
6181.381485	1989	1.0
5237.915225	1990	1.0
5285.164195	1991	1.0
8376.061302	1992	1.0
7708.453412	1993	1.0
7584.348398	1994	1.0
6857.312783	1995	1.0
8673.571917	1996	1.0
3151.101658	1997	1.0
4214.202876	1998	1.0
4816.414211	1999	1.0
5011.828389	2000	1.0
3387.202805	2001	1.0
2452.138452	2002	1.0
1490.018131	2003	1.0
1750.188782	2004	1.0
966.080702	2005	1.0
510.8182355	2006	1.0
405.3577101	2007	1.0
511.0469504	2008	1.0

```
817.3896664    2009   1.0
1026.606114    2010   1.0
1456.016121    2011   1.0
1646.362201    2012   1.0

19 # Number of index observations
# Units: 0=numbers,1=biomass,2=F; Errortype: -1=normal,0=lognormal,>0=T
# Fleet Units Errortype
1 1 0 # fleet 1: FISHERY
2 1 0 # fleet 2: SURVEY
3 1 0 # fleet 2: SURVEY
#_year seas index obs se(log)
1980   1   2   8962.196869   0.334858607   #Tri
1983   1   2   13130.56899   0.191635919
1986   1   2   9855.239779   0.278644309
1989   1   2   6539.568103   0.286905232
1992   1   2   8630.494905   0.2667461
1995   1   2   2924.167225   0.303715645
1998   1   2   21151.41523   0.305317909
2001   1   2   5021.728611   0.319566943
2004   1   2   17350.23909   0.845518222
2003   1   3   21205.26474   0.473755244   #NWFSC
2004   1   3   19239.33425   0.552662098
2005   1   3   23343.35736   0.43220822
2006   1   3   9036.145701   0.474465699
2007   1   3   16088.99761   0.435602184
2008   1   3   14246.9584    0.470159183
2009   1   3   7320.101698   0.473810099
2010   1   3   37589.2747    0.417056884
2011   1   3   25480.36039   0.424339276
2012   1   3   14678.0086    0.440904381

0 #_N_fleets_with_discard
0 #_N_discard_obs

0 #_N_meanbodywt_obs
30 #_DF_meanwt

## Population size structure
1 # length bin method: 1=use databins; 2=generate from binwidth,min,max below; 3=read vector
-1 #_comp_tail_compression
1e-007 #_add_to_comp
0 #_combine males into females at or below this bin number
33 #_N_LengthBins
2    4    6    8    10   12   14   16   18   20   22   24
     26   28   30   32   34   36   38   40   42   44   46
     48   50   52   54   56   58   60   62   64   66
0 #_N_Length_obs
#Yr Seas Flt/Svy Gender Part Nsamp datavector(female-male)
58 #_N_age_bins
1    2    3    4    5    6    7    8    9    10   11   12
     13   14   15   16   17   18   19   20   21   22   23
     24   25   26   27   28   29   30   31   32   33   34
     35   36   37   38   39   40   41   42   43   44   45
     46   47   48   49   50   51   52   53   54   55   56
     57   58
0 #_N_ageerror_definitions
0 #_N_Agecomp_obs
1 #_Lbin_method: 1=poplenbins; 2=datalenbins; 3=lengths
0 #_combine males into females at or below this bin number
0 #_N_MeanSize-at-Age_obs
0 #_N_environ_variables
0 #_N_environ_obs
0 # N sizefreq methods to read
0 # no tag data
0 # no morphcomp data
999 # End data file
```

Control file

#C growth parameters are estimated
1 #_N_Growth_Patterns
1 #_N_Morphs_Within_GrowthPattern
0 #_Nblock_Patterns
0.5 #_fracfemale
0 #_natM_type:_0=1Parm; 1=N_breakpoints;_2=Lorenzen;_3=agespecific;_4=agespec_withseasinterpolate
#_no additional input for selected M option; read 1P per morph
1 # GrowthModel: 1=vonBert with L1andL2; 2=Richards with L1andL2; 3=not implemented; 4=not implemented
1 #_Growth_Age_for_L1
999 #_Growth_Age_for_L2 (999 to use as Linf)
0 #_SD_add_to_LAA (set to 0.1 for SS2 V1.x compatibility)
0 #_CV_Growth_Pattern: 0 CV=f(LAA); 1 CV=F(A); 2 SD=F(LAA); 3 SD=F(A)
1 #_maturity_option: 1=length logistic; 2=age logistic; 3=read age-maturity matrix by growth_pattern; 4=read age-fecundity; 5=read fec and wt from wtatage.ss
#_placeholder for empirical age-maturity by growth pattern
0 #_First_Mature_Age
1 #_fecundity option:(1)eggs=Wt*(a+b*Wt);(2)eggs=a*L^b;(3)eggs=a*Wt^b
0 #_hermaphroditism option: 0=none; 1=age-specific fxn
1 #_parameter_offset_approach (1=none, 2= M, G, CV_G as offset from female-GP1, 3=like SS2 V1.x)
2 #_env/block/dev_adjust_method (1=standard; 2=logistic transform keeps in base parm bounds; 3=standardw/ no bound check)
#
#_growth_parms
#_LO HI INIT PRIOR PR_type SD PHASE env-var use_dev dev_minyr dev_maxyr dev_stddev Block Block_Fxn
0.001 2 0.11 -2.207 3 0.4 2 0 0 0 0 0 0 0 # NatM_p_1_Fem_GP_1
1 26.87012886 13.43506443 36 -1 10 -2 0 0 0 0 0 0 0 # L_at_Amin_Fem_GP_1
1 104.42 52.21 70 -1 10 -4 0 0 0 0 0 0 0 # L_at_Amax_Fem_GP_1
0.05 0.34 0.17 0.15 -1 0.8 -4 0 0 0 0 0 0 0 # VonBert_K_Fem_GP_1
0.05 0.2 0.1 0.1 -1 0.8 -3 0 0 0 0 0 0 0 # CV_young_Fem_GP_1
0.05 0.2 0.1 0.1 -1 0.8 -3 0 0 0 0 0 0 0 # CV_old_Fem_GP_1
0.001 2 0.11 -2.207 3 0.4 2 0 0 0 0 0 0 0 # NatM_p_1_Mal_GP_1
1 26.87012886 12.51 36 -1 10 -2 0 0 0 0 0 0 0 # L_at_Amin_Mal_GP_1
1 104.42 47.57 70 -1 10 -4 0 0 0 0 0 0 0 # L_at_Amax_Mal_GP_1
0.05 0.34 0.19 0.15 -1 0.8 -4 0 0 0 0 0 0 0 # VonBert_K_Mal_GP_1
0.05 0.2 0.1 0.1 -1 0.8 -3 0 0 0 0 0 0 0 # CV_young_Mal_GP_1
0.05 0.2 0.1 0.1 -1 0.8 -3 0 0 0 0 0 0 0 # CV_old_Mal_GP_1
-3 3 1.32E-05 2.44E-06 -1 0.8 -3 0 0 0 0 0 0 0 # Wtlen_1_Fem
-3 4 3.03 3.34694 -1 0.8 -3 0 0 0 0 0 0 0 # Wtlen_2_Fem
1 1000 37 9 -1 0.8 -3 0 0 0 0 0 0 0 # Mat50%_Fem
-30 3 -0.47 -0.25 -1 0.8 -3 0 0 0 0 0 0 0 # Mat_slope_Fem
-3 3 1 1 -1 0.8 -3 0 0 0 0 0 0 0 # Eggs/kg_inter_Fem
-3 3 0 0 -1 0.8 -3 0 0 0 0 0 0 0 # Eggs/kg_slope_wt_Fem
-3 3 1.24E-05 2.44E-06 -1 0.8 -3 0 0 0 0 0 0 0 # Wtlen_1_Mal
-3 4 3.06 3.34694 -1 0.8 -3 0 0 0 0 0 0 0 # Wtlen_2_Mal
0 0 0 0 -1 0 -4 0 0 0 0 0 0 0 # RecrDist_GP_1
0 0 0 0 -1 0 -4 0 0 0 0 0 0 0 # RecrDist_Area_1
0 0 0 0 -1 0 -4 0 0 0 0 0 0 0 # RecrDist_Seas_1
0 0 0 0 -1 0 -4 0 0 0 0 0 0 0 # CohortGrowDev
#
#_seasonal_effects_on_biology_parms
0 0 0 0 0 0 0 0 0 0
#_Spawner-Recruitment
3 #_SR_function

```
#_LO	HI	INIT	PRIOR	PR_type	SD	PHASE
1 31 12.2 12.2 -1 10 1  # SR_R0
0.25 0.99 0.779	0.779  2 0.152 3 # SR_steep
0	2	0.01	0.8	-1	0.8	-4	#	SR_sigmaR
-5	5	0.1	0	-1	1	-3	#	SR_envlink
-5	5	0	0	-1	1	-4	#	SR_R1_offset
0	0	0	0	-1	0	-99	#	SR_autocorr
0	#_SR_env_link
0	#_SR_env_target_0=none;1=devs;_2=R0;_3=steepness
0	#do_recdev:	0=none;	1=devvector;	2=simple	deviations
2012	#	first	year	of	main	recr_devs
2012	#	last	year	of	main	recr_devs
-2	#_recdev	phase
1	#	(0/1)	to	read	13	advanced	options
0	#_recdev_early_start	(0=none;	neg	value	makes	relative	to	recdev_start)
-4	#_recdev_early_phase
-1	#_forecast_recruitment
1	#_lambda	for	fore_recr_like	occurring	before	endyr+1
1990	#_last_early_yr_nobias_adj_in_MPD
1999	#_first_yr_fullbias_adj_in_MPD
2000	#_last_yr_fullbias_adj_in_MPD
2012	#_first_recent_yr_nobias_adj_in_MPD
1.0	#_max_bias_adj_in_MPD
0	#_period	of	cycles	in	recruitment	(N	parms	read	below)
-5	#min	rec_dev
5	#max	rec_dev
0	#_read_recdevs
#Fishing Mortality info
0.3 # F ballpark for tuning early phases
-2001 # F ballpark year (neg value to disable)
1 # F_Method:  1=Pope; 2=instan. F; 3=hybrid (hybrid is recommended)
0.9 # max F or harvest rate, depends on F_Method
#_initial_F_parms
#_LO HI INIT PRIOR PR_type SD PHASE
 0 1 0 0.01 0 99 -1 # InitF_1FISHERY1
#_Q_setup
 # Q_type options:  <0=mirror, 0=median_float, 1=mean_float, 2=parameter, 3=parm_w_random_dev, 4=parm_w_randwalk,
5=mean_unbiased_float_assign_to_parm
 #_Den-dep  env-var  extra_se  Q_type
 0 0 0 0 # 1 FISHERY1
 0 0 1 0 # 2 SURVEY1
 0 0 1 0 # 2 SURVEY1
#_Cond 0 #_If q has random component, then 0=read one parm for each fleet with random q; 1=read a parm for each year of index
#_Q_parms(if_any)
# LO HI INIT PRIOR PR_type SD PHASE
 0 5 0 0.1 -1 0.1 1
 0 5 0 0.1 -1 0.1 1
#_size_selex_types
#_Pattern Discard Male Special
 1 0 0 0 # 1 FISHERY1
 1 0 0 0 # 2 SURVEY1
 1 0 0 0 # 2 SURVEY1
#_age_selex_types
#_Pattern ___ Male Special
 10 0 0 0 # 2 SURVEY1
 10 0 0 0 # 2 SURVEY1
 10 0 0 0 # 2 SURVEY1
#_LO HI INIT PRIOR PR_type SD PHASE env-var use_dev dev_minyr dev_maxyr dev_stddev Block Block_Fxn
 0 40 37 10 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_1P_1_FISHERY1
 0 65 6.264764 64 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_1P_2_FISHERY1
 0 40 37 10 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_1P_1_FISHERY1
 0 65 6.264764 64 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_1P_2_FISHERY1
 0 40 37 10 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_1P_1_FISHERY1
 0 65 6.264764 64 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_1P_2_FISHERY1
0 # Tagging flag: 0=none,1=read parameters for tagging
### Likelihood related quantities ###
# variance/sample size adjustment by fleet
0 # Do variance adjustments
1	# Max N lambda phases: read this N values for each item below
1	# SD offset (CPUE, discard, mean body weight, recruitment devs): 0=omit log(s) term, 1=include
```

0 # N changes to default Lambdas = 1.0
0 # extra SD pointer
999 # end of control file

Starter file

#C starter comment here
YTRK_N_data.ss
YTRK_N_control.ss
0 # 0=use init values in control file; 1=use ss3.par
0 # run display detail (0,1,2)
0 # detailed age-structured reports in REPORT.SSO (0,1)
1 # write detailed checkup.sso file (0,1)
4 # write parm values to ParmTrace.sso (0=no,1=good,active; 2=good,all; 3=every_iter,all_parms; 4=every,active)
1 # write to cumreport.sso (0=no,1=likeandtimeseries; 2=add survey fits)
1 # Include prior_like for non-estimated parameters (0,1)
1 # Use Soft Boundaries to aid convergence (0,1) (recommended)
1 # Number of bootstrap datafiles to produce
6 # Turn off estimation for parameters entering after this phase
1 # MCeval burn interval
1 # MCeval thin interval
0.1 # jitter initial parm value by this fraction
-1 # min yr for sdreport outputs (-1 for styr)
-2 # max yr for sdreport outputs (-1 for endyr; -2 for endyr+Nforecastyrs
0 # N individual STD years
#vector of year values
0.0001 # final convergence criteria (e.g., 1.0e-04)
0 # retrospective year relative to end year (e.g., -4)
0 # min age for calc of summary biomass
1 # Depletion basis: denom is: 0=skip; 1=rel X*B0; 2=rel X*Bmsy; 3=rel X*B_styr
1 # Fraction (X) for Depletion denominator (e.g., 0.4)
1 # SPR_report_basis: 0=skip; 1=(1-SPR)/(1-SPR_tgt); 2=(1-SPR)/(1-SPR_MSY); 3=(1-SPR)/(1-SPR_Btarget); 4=rawSPR
3 # F_report_units: 0=skip; 1=exploitation(Bio); 2=exploitation(Num); 3=sum(Frates)
0 # F_report_basis: 0=raw; 1=F/Fspr; 2=F/Fmsy ; 3=F/Fbtgt
999 # check value for end of file

Forecast file

1 # Benchmarks: 0=skip; 1=calc F_spr,F_btgt,F_msy
2 # MSY: 1= set to F(SPR); 2=calc F(MSY); 3=set to F(Btgt); 4=set to F(endyr)
0.5 # SPR target (e.g., 0.40)
0.4 # Biomass target (e.g., 0.40)
#_Bmark_years: beg_bio, end_bio, beg_selex, end_selex, beg_relF, end_relF (enter actual year, or values of 0 or -integer to be rel. endyr)
 0 0 0 0 0 0
2010 2010 2010 2010 2010 2010 # after processing
1 #Bmark_relF_Basis: 1 = use year range; 2 = set relF same as forecast below
#
1 # Forecast: 0=none; 1=F(SPR); 2=F(MSY) 3=F(Btgt); 4=Ave F (uses first-last relF yrs); 5=input annual F scalar
12 # N forecast years
0.2 # F scalar (only used for Do_Forecast==5)
#_Fcast_years: beg_selex, end_selex, beg_relF, end_relF (enter actual year, or values of 0 or -integer to be rel. endyr)
 0 0 0 0
2010 2010 2010 2010 # after processing
1 # Control rule method (1=catch=f(SSB) west coast; 2=F=f(SSB))
0.4 # Control rule Biomass level for constant F (as frac of Bzero, e.g., 0.40); (Must be > the no F level below)
0.1 # Control rule Biomass level for no F (as frac of Bzero, e.g., 0.10)
1 # Control rule target as fraction of Flimit (e.g., 0.75)
3 #_N forecast loops (1=OFL only; 2=ABC; 3=get F from forecast ABC catch with allocations applied)
3 #_First forecast loop with stochastic recruitment
0 #_Forecast loop control #3 (reserved for future bellsandwhistles)
0 #_Forecast loop control #4 (reserved for future bellsandwhistles)
0 #_Forecast loop control #5 (reserved for future bellsandwhistles)
2013 #FirstYear for caps and allocations (should be after years with fixed inputs)
0 # stddev of log(realized catch/target catch) in forecast (set value>0.0 to cause active impl_error)
0 # Do West Coast gfish rebuilder output (0/1)
2013 # Rebuilder: first year catch could have been set to zero (Ydecl)(-1 to set to 1999)
2013 # Rebuilder: year for current age structure (Yinit) (-1 to set to endyear+1)
1 # fleet relative F: 1=use first-last alloc year; 2=read seas(row) x fleet(col) below
Note that fleet allocation is used directly as average F if Do_Forecast=4

2 # basis for fcast catch tuning and for fcast catch caps and allocation (2=deadbio; 3=retainbio; 5=deadnum; 6=retainnum)
Conditional input if relative F choice = 2
Fleet relative F: rows are seasons, columns are fleets
#_Fleet: FISHERY
1
max totalcatch by fleet (-1 to have no max) must enter value for each fleet
-1
max totalcatch by area (-1 to have no max); must enter value for each fleet
-1
fleet assignment to allocation group (enter group ID# for each fleet, 0 for not included in an alloc group)
0
#_Conditional on >1 allocation group
allocation fraction for each of: 0 allocation groups
no allocation groups
2 # Number of forecast catch levels to input (else calc catch from forecast F)
2 # basis for input Fcast catch: 2=dead catch; 3=retained catch; 99=input Hrate(F) (units are from fleetunits; note new codes in SSV3.20)
Input fixed catch values
#Year Seas Fleet Catch(or_F)
2013 1 1 1376.3
2014 1 1 1376.3
999 # verify end of input

Appendix A.4. English sole

Data file

Data-mod 2013: ENGLISH SOLE
##
Global model specifications
1876 # Start year
2012 # End year
1 # Number of seasons/year
12 # Number of months/season
1 # Spawning occurs at beginning of season
1 # Number of fishing fleets
3 # Number of surveys
1 # Number of areas
FISHERY%SURVEY1%SURVEY2%SURVEY3
0.5417 0.5417 0.5417 0.5417 #fleet timing_in_season
1 1 1 1 # Area of each fleet
1 # Units for catch by fishing fleet: 1=Biomass(mt),2=Numbers(1000s)
0.01 # SE of log(catch) by fleet for equilibrium and continuous options
2 # Number of genders
30 # Number of ages in population dynamics
Catch section
0 # Initial equilibrium catch (landings + discard) by fishing fleet
137 # Number of lines of catch
Catch Year Season

1	1876	1
1	1877	1
1	1878	1
2	1879	1
2	1880	1
2	1881	1
3	1882	1
5	1883	1
5	1884	1
6	1885	1
7	1886	1
8	1887	1
10	1888	1
13	1889	1
15	1890	1
17	1891	1
21	1892	1
25	1893	1
31	1894	1
37	1895	1
43	1896	1

53	1897	1
63	1898	1
75	1899	1
90	1900	1
109	1901	1
130	1902	1
157	1903	1
189	1904	1
226	1905	1
271	1906	1
326	1907	1
391	1908	1
469	1909	1
564	1910	1
677	1911	1
813	1912	1
977	1913	1
1173	1914	1
1409	1915	1
2826	1916	1
3865	1917	1
3132	1918	1
2475	1919	1
1715	1920	1
2184	1921	1
3159	1922	1
3186	1923	1
4110	1924	1
4018	1925	1
3865	1926	1
4690	1927	1
4143	1928	1
4811	1929	1
3732	1930	1
1928	1931	1
3540	1932	1
3346	1933	1
2845	1934	1
3226	1935	1
3404	1936	1
3159	1937	1
2543	1938	1
2991	1939	1
3038	1940	1
2202	1941	1
2064	1942	1
3638	1943	1
2141	1944	1
1887	1945	1
4998	1946	1
3334	1947	1
6030	1948	1
3546	1949	1
5673	1950	1
4189	1951	1
3824	1952	1
2911	1953	1
2623	1954	1
2829	1955	1
3787	1956	1
4436	1957	1
5520	1958	1
5427	1959	1
4338	1960	1
4188	1961	1
4496	1962	1
4489	1963	1
4742	1964	1
5043	1965	1
5522	1966	1

5192	1967	1
5468	1968	1
3788	1969	1
3102	1970	1
2851	1971	1
3300	1972	1
3773	1973	1
3858	1974	1
4579	1975	1
5755	1976	1
3735	1977	1
4511	1978	1
4710	1979	1
4143	1980	1
3780	1981	1
3833	1982	1
3091	1983	1
2458	1984	1
2955	1985	1
3153	1986	1
3979	1987	1
3422	1988	1
3780	1989	1
2907	1990	1
3339	1991	1
2556	1992	1
2534	1993	1
1818	1994	1
1762	1995	1
1540	1996	1
1911	1997	1
1441	1998	1
1245	1999	1
1061	2000	1
1363	2001	1
1683	2002	1
1125	2003	1
1218	2004	1
1115	2005	1
1078	2006	1
789.4	2007	1
420.1	2008	1
415.5	2009	1
258.1	2010	1
198.1	2011	1
216.1	2012	1

19 # Number of index observations
Units: 0=numbers,1=biomass,2=F; Errortype: -1=normal,0=lognormal,>0=T
Fleet Units Errortype
1 1 0 # fleet 1: FISHERY
2 1 0 # fleet 2: SURVEY
3 1 0 # fleet 2: SURVEY
4 1 0 # fleet 2: SURVEY
#_year seas index obs se(log)

1980	1	2	5068.04	0.191990701	#Tri early
1983	1	2	11352.60	0.5#0.157586493	
1986	1	2	14077.63	0.136826903	
1989	1	2	13993.23	0.118986159	
1992	1	2	12412.52	0.144787134	
1995	1	3	15671.87	0.139753547	#Tri late
1998	1	3	20768.12	0.118109976	
2001	1	3	26072.37	0.123467305	
2004	1	3	44845.17	0.128683219	
2003	1	4	47397.74071	0.14066723	#NWFSC
2004	1	4	54628.85833	0.141405536	
2005	1	4	40089.20896	0.125322389	
2006	1	4	23917.21089	0.138389159	
2007	1	4	20615.2281	0.126679898	
2008	1	4	18167.64655	0.133558888	

2009 1 4 21878.99142 0.139215613
2010 1 4 20955.23688 0.129787034
2011 1 4 24911.2161 0.129060731
2012 1 4 26682.23605 0.135269391

0 #_N_fleets_with_discard
0 #_N_discard_obs
0 #_N_meanbodywt_obs
30 #_DF_meanwt
Population size structure
1 # length bin method: 1=use databins; 2=generate from binwidth,min,max below; 3=read vector
-1 #_comp_tail_compression
1e-007 #_add_to_comp
0 #_combine males into females at or below this bin number
23 #_N_LengthBins
2 4 6 8 10 12 14 16 18 20 22 24
26 28 30 32 34 36 38 40 42 44 46
0 #_N_Length_obs
27 #_N_age_bins
1 2 3 4 5 6 7 8 9 10 11 12
13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
0 #_N_ageerror_definitions
0 #_N_Agecomp_obs
1 #_Lbin_method: 1=poplenbins; 2=datalenbins; 3=lengths
0 #_combine males into females at or below this bin number
0 #_N_MeanSize-at-Age_obs
0 #_N_environ_variables
0 #_N_environ_obs
0 # N sizefreq methods to read
0 # no tag data
0 # no morphcomp data
999 # End data file

Control file
#C growth parameters are estimated
#_data_and_control_files: simple.dat // simple.ctl
#_SS-V3.10b-safe;_02/24/2010;_Stock_Synthesis_by_Richard_Methot_(NOAA)_using_ADMB
1 #_N_Growth_Patterns
1 #_N_Morphs_Within_GrowthPattern
0 #_Nblock_Patterns
#_Cond 0 #_blocks_per_pattern
begin and end years of blocks
#
0.5 #_fracfemale
0 #_natM_type:_0=1Parm; 1=N_breakpoints;_2=Lorenzen;_3=agespecific;_4=agespec_withseasinterpolate
#_no additional input for selected M option; read 1P per morph
1 # GrowthModel: 1=vonBert with L1andL2; 2=Richards with L1andL2; 3=not implemented; 4=not implemented
2 #_Growth_Age_for_L1
20 #_Growth_Age_for_L2 (999 to use as Linf)
0 #_SD_add_to_LAA (set to 0.1 for SS2 V1.x compatibility)
0 #_CV_Growth_Pattern
1 #_maturity_option: 1=length logistic
0 #_First_Mature_Age
1 #_fecundity option:(1)eggs=Wt*(a+b*Wt);(2)eggs=a*L^b;(3)eggs=a*Wt^b
0 #_hermaphroditism option: 0=none; 1=age-specific fxn
1 #_parameter_offset_approach (1=none, 2= M, G, CV_G as offset from female-GP1, 3=like SS2 V1.x)
2 #_env/block/dev_adjust_method
#_growth_parms
#_LO HI INIT PRIOR PR_type SD PHASE env-var use_dev dev_minyr dev_maxyr
dev_stddev Block Block_Fxn
0.001 2 0.26 -1.347 3 0.4 2 0 0 0 0 0 0 0 # NatM_p_1_Fem_GP_1
5 25 17.3386 16.37 0 50 -2 0 0 0 0 0
0 0 # L_at_Amin_Fem_GP_1
25 55 40.5617 39.814 0 50 -2 0 0 0 0 0 0 0 # L_at_Amax_Fem_GP_1
0.01 1.5 0.357007 0.39273 0 50 -2 0 0 0 0 0
0 0 # VonBert_K_Fem_GP_1
0.01 0.9 0.102856 0.10145 0 50 -2 0 0 0 0 0
0 0 # CV_young_Fem_GP_1

```
0.01	0.9	0.102856	0.10145	0	50	-2	0	0	0	0	0
	0	0	#	CV_young_Fem_GP_1

0.001 2 0.26	-1.347	3	0.4	2 0 0 0 0 0 0 0 # NatM_p_1_Fem_GP_1
5	25	17.3386	16.37	0	50	-2	0	0	0	0	0
	0	0	#	L_at_Amin_Fem_GP_1
25	55	23.9845115903962	39.814	0	50	-2 0 0 0 0 0 0 0 # L_at_Amax_Fem_GP_1
0.01	1.5	0.480107669127594	0.39273	0	50	-2	0	0	0	0
	0	0	0	#	VonBert_K_Fem_GP_1
0.01	0.9	0.178	0.10145	0	50	-2	0	0	0	0	0
	0	0	#	CV_young_Fem_GP_1
0.01	0.9	0.178	0.10145	0	50	-2	0	0	0	0	0
	0	0	#	CV_young_Fem_GP_1

-3	3	0.00000821 0.00000547424	-1	0.8	-3	0	0	0	0
	0	0	0	#	Wtlen_1_Fem
-3	4	3.0226	3.03	-1	0.8	-3	0	0	0	0	0
	0	0	#	Wtlen_2_Fem
 0	50	 31	25 -1 0.8 -3 0 0 0 0 0 0 0 # Mat50%_Fem
 -1	1	 -0.6104999 -0.5	-1	0.8	-3	0	0	0	0	0
	0	0	#	Mat_slope_Fem
-3	3	1	1	-1	0.8	-3	0	0	0	0	0
	0	0	#	Eggs/kg_inter_Fem
-3	3	0	0	-1	0.8	-3	0	0	0	0	0
	0	0	#	Eggs/kg_slope_wt_Fem
-3	3	0.00000267 1.55E-05 -1	0.8	-3	0	0	0	0	0
	0	0	#	Wtlen_1_Mal
-3	4	3.25	3.03	-1	0.8	-3	0	0	0	0	0
	0	0	#	Wtlen_2_Mal
0	0	0	0	-1	0	-4	0	0	0	0	0
	0	0	#	RecrDist_GP_1
0	0	0	0	-1	0	-4	0	0	0	0	0
	0	0	#	RecrDist_Area_1
0	0	0	0	-1	0	-4	0	0	0	0	0
	0	0	#	RecrDist_Seas_1
0	0	0	0	-1	0	-4	0	0	0	0	0
	0	0	#	CohortGrowDev
#_seasonal_effects_on_biology_parms
	0	0	0	0	0	0	0	0	0	0
#_Spawner-Recruitment
3	#_SR_function
#_LO	HI	INIT	PRIOR	PR_type	SD	PHASE
1 31 10 10 -1 10 1	#	SR_R0
0.25 0.99 0.85 0.8  0 0.093 3 # SR_steep
0	2	0.01	0.8	-1	0.8	-4	#	SR_sigmaR
-5	5	0.1	0	-1	1	-3	#	SR_envlink
-5	5	0	0	-1	1	-4	#	SR_R1_offset
0	0	0	0	-1	0	-99	#	SR_autocorr
0	#_SR_env_link
0	#_SR_env_target_0=none;1=devs;_2=R0;_3=steepness
0	#do_recdev:	0=none;	1=devvector;	2=simple	deviations
2010	#	first	year	of	main	recr_devs
2010	#	last	year	of	main	recr_devs
-2	#_recdev	phase
1	#	(0/1)	to	read	13	advanced	options
0	#_recdev_early_start	(0=none;	neg	value	makes	relative	to	recdev_start)
-4	#_recdev_early_phase
-1	#_forecast_recruitment
1	#_lambda	for	fore_recr_like	occurring	before	endyr+1
1990	#_last_early_yr_nobias_adj_in_MPD
1999	#_first_yr_fullbias_adj_in_MPD
2000	#_last_yr_fullbias_adj_in_MPD
2010	#_first_recent_yr_nobias_adj_in_MPD
1.0	#_max_bias_adj_in_MPD
0	#_period	of	cycles	in	recruitment	(N	parms	read	below)
-5	#min	rec_dev
5	#max	rec_dev
0	#_read_recdevs
#
#Fishing Mortality info
```

```
0.3 # F ballpark for tuning early phases
-2001 # F ballpark year (neg value to disable)
1 # F_Method:  1=Pope; 2=instan. F; 3=hybrid (hybrid is recommended)
0.9 # max F or harvest rate, depends on F_Method
#_initial_F_parms
#_LO HI INIT PRIOR PR_type SD PHASE
 0 1 0 0.01 0 99 -1 # InitF_1FISHERY1
#_Q_setup
 # A=do power, B=env-var, C=extra SD, D=devtype(<0=mirror, 0/1=none, 2=cons, 3=rand, 4=randwalk); E:0=num/1=bio/2=F, F:-
1=norm/0=lognorm/>0=T
 #_A  B  C  D  E  F
 0 0 0 0 # 1 FISHERY1
 0 0 1 0 # 2 SURVEY1
 0 0 1 0 # 2 SURVEY1
 0 0 1 0 # 2 SURVEY1
#
#_Cond 0 #_If q has random component, then 0=read one parm for each fleet with random q; 1=read a parm for each year of index
#_Q_parms(if_any)
# LO HI INIT PRIOR PR_type SD PHASE
0 1000 0.01 0.01 0 99 1 # InitF_1FISHERY1
0 1000 0.01 0.01 0 99 1 # InitF_1FISHERY1
0 1000 0.01 0.01 0 99 1 # InitF_1FISHERY1
#_size_selex_types
#_Pattern Discard Male Special
 1 0 0 0 # 1 FISHERY1
 1 0 0 0 # 2 SURVEY1
 1 0 0 0 # 2 SURVEY1
 1 0 0 0 # 2 SURVEY1
#
#_age_selex_types
#_Pattern ___ Male Special
 10 0 0 0 # 1 FISHERY1
 10 0 0 0 # 2 SURVEY1
 10 0 0 0 # 2 SURVEY1
 10 0 0 0 # 2 SURVEY1
#_LO HI INIT PRIOR PR_type SD PHASE env-var use_dev dev_minyr dev_maxyr dev_stddev Block Block_Fxn
 0 40 31 83 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_1P_1_FISHERY1
 0 80 4.822997 30 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_1P_2_FISHERY1
 0 40 31 83 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_1P_1_FISHERY1
 0 80 4.822997 30 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_1P_2_FISHERY1
 0 40 31 83 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_1P_1_FISHERY1
 0 80 4.822997 30 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_1P_2_FISHERY1
 0 40 31 83 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_1P_1_FISHERY1
 0 80 4.822997 30 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_1P_2_FISHERY1
# Tag loss and Tag reporting parameters go next
0  # TG_custom:  0=no read; 1=read if tags exist
#_Cond -6 6 1 1 2 0.01 -4 0 0 0 0 0 0 0  #_placeholder if no parameters
#
0 #_Variance_adjustments_to_input_values
1 #_maxlambdaphase
1 #_sd_offset
0 # number of changes to make to default Lambdas (default value is 1.0)
0 # (0/1) read specs for more stddev reporting
999
```

Starter file

```
ENGL_data.ss #_datfile
ENGL_control.ss #_datfile
#control_modified.ss #_ctlfile
0 #_init_values_src
0 #_run_display_detail
0 #_detailed_age_structure
1 #_checkup
4 #_parmtrace
1 #_cumreport
1 #_prior_like
1 #_soft_bounds
1 #_N_bootstraps
6 #_last_estimation_phase
```

1 #_MCMCburn
1 #_MCMCthin
0.5 #_jitter_fraction
-1 #_minyr_sdreport
-2 #_maxyr_sdreport
0 #_N_STD_yrs
1e-04 #_converge_criterion
0 #_retro_yr
0 #_min_age_summary_bio
1 #_depl_basis
1 #_depl_denom_frac
1 #_SPR_basis
3 #_F_report_units
0 #_F_report_basis
#
999

Forecast file

1 # Benchmarks: 0=skip; 1=calc F_spr,F_btgt,F_msy
2 # MSY: 1= set to F(SPR); 2=calc F(MSY); 3=set to F(Btgt); 4=set to F(endyr)
0.3 # SPR target (e.g., 0.40)
0.25 # Biomass target (e.g., 0.40)
#_Bmark_years: beg_bio, end_bio, beg_selex, end_selex, beg_relF, end_relF (enter actual year, or values of 0 or -integer to be rel. endyr)
 0 0 0 0 0 0
2010 2010 2010 2010 2010 2010 # after processing
1 #Bmark_relF_Basis: 1 = use year range; 2 = set relF same as forecast below
#
1 # Forecast: 0=none; 1=F(SPR); 2=F(MSY) 3=F(Btgt); 4=Ave F (uses first-last relF yrs); 5=input annual F scalar
12 # N forecast years
0.2 # F scalar (only used for Do_Forecast==5)
#_Fcast_years: beg_selex, end_selex, beg_relF, end_relF (enter actual year, or values of 0 or -integer to be rel. endyr)
 0 0 0 0
2010 2010 2010 2010 # after processing
1 # Control rule method (1=catch=f(SSB) west coast; 2=F=f(SSB))
0.25 # Control rule Biomass level for constant F (as frac of Bzero, e.g., 0.40); (Must be > the no F level below)
0.05 # Control rule Biomass level for no F (as frac of Bzero, e.g., 0.10)
1 # Control rule target as fraction of Flimit (e.g., 0.75)
3 #_N forecast loops (1=OFL only; 2=ABC; 3=get F from forecast ABC catch with allocations applied)
3 #_First forecast loop with stochastic recruitment
0 #_Forecast loop control #3 (reserved for future bellsandwhistles)
0 #_Forecast loop control #4 (reserved for future bellsandwhistles)
0 #_Forecast loop control #5 (reserved for future bellsandwhistles)
2013 #FirstYear for caps and allocations (should be after years with fixed inputs)
0 # stddev of log(realized catch/target catch) in forecast (set value>0.0 to cause active impl_error)
0 # Do West Coast gfish rebuilder output (0/1)
2013 # Rebuilder: first year catch could have been set to zero (Ydecl)(-1 to set to 1999)
2013 # Rebuilder: year for current age structure (Yinit) (-1 to set to endyear+1)
1 # fleet relative F: 1=use first-last alloc year; 2=read seas(row) x fleet(col) below
Note that fleet allocation is used directly as average F if Do_Forecast=4
2 # basis for fcast catch tuning and for fcast catch caps and allocation (2=deadbio; 3=retainbio; 5=deadnum; 6=retainnum)
Conditional input if relative F choice = 2
Fleet relative F: rows are seasons, columns are fleets
#_Fleet: FISHERY
1
max totalcatch by fleet (-1 to have no max) must enter value for each fleet
 -1
max totalcatch by area (-1 to have no max); must enter value for each fleet
 -1
fleet assignment to allocation group (enter group ID# for each fleet, 0 for not included in an alloc group)
 0
#_Conditional on >1 allocation group
allocation fraction for each of: 0 allocation groups
no allocation groups
2 # Number of forecast catch levels to input (else calc catch from forecast F)
3 # basis for input Fcast catch: 2=dead catch; 3=retained catch; 99=input Hrate(F) (units are from fleetunits; note new codes in SSV3.20)
Input fixed catch values
#Year Seas Fleet Catch(or_F)

2013 1 1 224.1
2014 1 1 224.1
999 # verify end of input

Appendix A.5. Rex sole

Data file

Data-mod 2013: REX SOLE
##
Global model specifications
1896 # Start year
2012 # End year
1 # Number of seasons/year
12 # Number of months/season
1 # Spawning occurs at beginning of season
1 # Number of fishing fleets
3 # Number of surveys
1 # Number of areas
FISHERY%SURVEY1%SURVEY2%SURVEY3
0.5 0.5 0.5 0.5 # fleet timing_in_season
1 1 1 1 # Area of each fleet
1 # Units for catch by fishing fleet: 1=Biomass(mt),2=Numbers(1000s)
0.01 # SE of log(catch) by fleet for equilibrium and continuous options
2 # Number of genders
24 # Number of ages in population dynamics
Catch section
0 # Initial equilibrium catch (landings + discard) by fishing fleet
117 # Number of lines of catch
Catch Year Season
1.20226E-05 1896 1.0
9.84327E-06 1897 1.0
7.66395E-06 1898 1.0
7.48234E-06 1899 1.0
7.26441E-06 1900 1.0
7.04648E-06 1901 1.0
6.82854E-06 1902 1.0
6.64693E-06 1903 1.0
6.429E-06 1904 1.0
6.21107E-06 1905 1.0
6.02946E-06 1906 1.0
5.81153E-06 1907 1.0
5.59359E-06 1908 1.0
5.41198E-06 1909 1.0
5.19405E-06 1910 1.0
4.97612E-06 1911 1.0
4.75819E-06 1912 1.0
4.57658E-06 1913 1.0
4.35865E-06 1914 1.0
4.14071E-06 1915 1.0
222.3095338 1916 1.0
302.8494836 1917 1.0
243.8417739 1918 1.0
191.8282666 1919 1.0
132.6028339 1920 1.0
169.004121 1921 1.0
244.3819692 1922 1.0
245.8634922 1923 1.0
306.5593447 1924 1.0
304.0328546 1925 1.0
300.1237275 1926 1.0
363.6154202 1927 1.0
356.7438399 1928 1.0
406.1886006 1929 1.0
379.0328902 1930 1.0
565.5680523 1931 1.0
378.7124472 1932 1.0
360.559652 1933 1.0
455.5334189 1934 1.0
430.1111819 1935 1.0

352.2289606	1936	1.0
314.2258872	1937	1.0
380.8249887	1938	1.0
476.0327907	1939	1.0
443.0165853	1940	1.0
299.4103347	1941	1.0
275.0303918	1942	1.0
715.1835957	1943	1.0
381.5808978	1944	1.0
349.1692147	1945	1.0
432.3854738	1946	1.0
619.6672894	1947	1.0
852.1710575	1948	1.0
967.4833747	1949	1.0
922.873363	1950	1.0
973.3426284	1951	1.0
1131.249766	1952	1.0
1429.236831	1953	1.0
1507.991395	1954	1.0
1979.550307	1955	1.0
2359.997146	1956	1.0
2137.397943	1957	1.0
2186.189357	1958	1.0
2032.989914	1959	1.0
1927.010355	1960	1.0
2001.876203	1961	1.0
2283.597107	1962	1.0
2490.741963	1963	1.0
1866.009864	1964	1.0
1801.201188	1965	1.0
2247.325095	1966	1.0
2240.099281	1967	1.0
2090.948768	1968	1.0
2422.36446	1969	1.0
1953.035886	1970	1.0
1582.710657	1971	1.0
1974.162849	1972	1.0
1928.451149	1973	1.0
1922.1665 1974	1.0	
1889.441009	1975	1.0
2125.617299	1976	1.0
1764.262976	1977	1.0
2090.591507	1978	1.0
2672.991997	1979	1.0
2074.65492	1980	1.0
2033.254495	1981	1.0
2287.0123 1982	1.0	
1898.047856	1983	1.0
1653.895329	1984	1.0
1838.105687	1985	1.0
1541.98092	1986	1.0
1526.248494	1987	1.0
1601.677446	1988	1.0
1441.016376	1989	1.0
1110.727732	1990	1.0
1447.342473	1991	1.0
1078.800383	1992	1.0
959.4598536	1993	1.0
1019.190828	1994	1.0
1111.80479	1995	1.0
1014.669843	1996	1.0
962.7805367	1997	1.0
746.6730947	1998	1.0
687.0644075	1999	1.0
626.7292151	2000	1.0
661.5025393	2001	1.0
687.7850328	2002	1.0
675.132215	2003	1.0
611.5029021	2004	1.0
661.5796157	2005	1.0

```
622.2913507    2006    1.0
623.0496337    2007    1.0
594.6041304    2008    1.0
609.323799     2009    1.0
514.7659745    2010    1.0
426.9124154    2011    1.0
422.4483261    2012    1.0

19 # Number of index observations
# Units: 0=numbers,1=biomass,2=F; Errortype: -1=normal,0=lognormal,>0=T
# Fleet Units Errortype
1 1 0 # fleet 1: FISHERY
2 1 0 # fleet 2: SURVEY
3 1 0 # fleet 2: SURVEY
4 1 0 # fleet 2: SURVEY
#_year seas index obs se(log)
1980    1    2    8036           0.197304579    #Tri early
1983    1    2    17104          0.157484028
1986    1    2    19087          0.276605599
1989    1    2    20178          0.112400015
1992    1    2    20256          0.113477226
1995    1    3    18457.53       0.080186251    #Tri late
1998    1    3    28192.95       0.085829686
2001    1    3    33262.61       0.070906238
2004    1    3    59170.60       0.083261572
2003    1    4    20811.0959     0.487843303    #NWFSC
2004    1    4    17199.64322    0.551739012
2005    1    4    25790.92561    0.506118486
2006    1    4    14262.68498    0.521127893
2007    1    4    12291.88076    0.481111835
2008    1    4    19095.92227    0.450884687
2009    1    4    19267.05323    0.509892141
2010    1    4    9613.628482    0.486724234
2011    1    4    12606.99044    0.463680605
2012    1    4    17028.72667    0.530939981

0 #_N_fleets_with_discard
0 #_N_discard_obs
0 #_N_meanbodywt_obs
30 #_DF_meanwt
## Population size structure
1 # length bin method: 1=use databins; 2=generate from binwidth,min,max below; 3=read vector
-1 #_comp_tail_compression
1e-007 #_add_to_comp
0 #_combine males into females at or below this bin number
30 #_N_LengthBins
2    4    6    8    10    12    14    16    18    20    22    24
     26   28   30   32    34    36    38    40    42    44    46
     48   50   52   54    56    58    60
0 #_N_Length_obs
#Yr Seas Flt/Svy Gender Part Nsamp datavector(female-male)
22 #_N_age_bins
1    2    3    4    5    6    7    8    9    10    11    12
     13   14   15   16   17   18   19   20   21    22
0 #_N_ageerror_definitions
0 #_N_Agecomp_obs
1 #_Lbin_method: 1=poplenbins; 2=datalenbins; 3=lengths
0 #_combine males into females at or below this bin number
0 #_N_MeanSize-at-Age_obs
0 #_N_environ_variables
0 #_N_environ_obs
0 # N sizefreq methods to read
0 # no tag data
0 # no morphcomp data
999 # End data file
```

Control file

```
#C growth parameters are estimated
1  #_N_Growth_Patterns
```

```
1 #_N_Morphs_Within_GrowthPattern
0 #_Nblock_Patterns
0.5 #_fracfemale
0 #_natM_type:_0=1Parm; 1=N_breakpoints;_2=Lorenzen;_3=agespecific;_4=agespec_withseasinterpolate
1 # GrowthModel: 1=vonBert with L1andL2; 2=Richards with L1andL2; 3=not implemented; 4=not implemented
1       #_Growth_Age_for_L1
999     #_Growth_Age_for_L2     (999    to      use     as      Linf)
0       #_SD_add_to_LAA (set    to      0.1     for     SS2     V1.x    compatibility)
0       #_CV_Growth_Pattern
1       #_maturity_option:      1=length        logistic
0       #_First_Mature_Age
1       #_fecundity     option:(1)eggs=Wt*(a+b*Wt);(2)eggs=a*L^b;(3)eggs=a*Wt^b
0       #_hermaphroditism       option: 0=none; 1=age-specific  fxn
1       #_parameter_offset_approach (1=none, 2= M, G, CV_G as offset from female-GP1, 3=like SS2 V1.x)
2       #_env/block/dev_adjust_method
#_LO    HI      INIT    PRIOR   PR_type SD      PHASE   env-var use_dev dev_minyr dev_maxyr
        dev_stddev      Block   Block_Fxn
0.001 2 0.2 -1.609 3 0.4 2 0 0 0 0 0 0 0 # NatM_p_1_Fem_GP_1
1 26.89759161 13.4487958 36 -1 10 -2 0 0 0 0 0 0 0 # L_at_Amin_Fem_GP_1
1 83.64 41.82 70 -1 10 -4 0 0 0 0 0 0 0 # L_at_Amax_Fem_GP_1
0.05 0.776 0.39 0.15 -1 0.8 -4 0 0 0 0 0 0 0 # VonBert_K_Fem_GP_1
0.05    0.2     0.1     0.1     -1      0.8     -3      0       0       0       0       0
        0       0       #       CV_young_Fem_GP_1
0.05    0.2     0.1     0.1     -1      0.8     -3      0       0       0       0       0
        0       0       #       CV_old_Fem_GP_1
0.001 2 0.2 -1.609 3 0.4 2 0 0 0 0 0 0 0 # NatM_p_1_Mal_GP_1
1 26.89759161 13.4487958 36 -1 10 -2 0 0 0 0 0 0 0 # L_at_Amin_Mal_GP_1
1 83.64 41.82 70 -1 10 -4 0 0 0 0 0 0 0 # L_at_Amax_Mal_GP_1
0.05 0.776 0.39 0.15 -1 0.8 -4 0 0 0 0 0 0 0 # VonBert_K_Mal_GP_1
0.05    0.2     0.1     0.1     -1      0.8     -3      0       0       0       0       0
        0       0       #       CV_young_Mal_GP_1
0.05    0.2     0.1     0.1     -1      0.8     -3      0       0       0       0       0
        0       0       #       CV_old_Mal_GP_1
-3      3       3.02E-06        2.44E-06        -1      0.8     -3      0       0       0       0       0
        0       0       #       Wtlen_1_Fem
-3      4       3.21    3.34694 -1      0.8     -3      0       0       0       0       0
        0       0       #       Wtlen_2_Fem
1 1000 35.17 55 -1 0.8 -3 0 0 0 0 0 0 0 # Mat50%_Fem
-30     3       -0.392  -0.25   -1      0.8     -3      0       0       0       0       0
        0       0       #       Mat_slope_Fem
-3      3       1       1       -1      0.8     -3      0       0       0       0       0
        0       0       #       Eggs/kg_inter_Fem
-3      3       0       0       -1      0.8     -3      0       0       0       0       0
        0       0       #       Eggs/kg_slope_wt_Fem
-3      3       2.67E-06        2.44E-06        -1      0.8     -3      0       0       0       0       0
        0       0       #       Wtlen_1_Mal
-3      4       3.25    3.34694 -1      0.8     -3      0       0       0       0       0
        0       0       #       Wtlen_2_Mal
0       0       0       0       -1      0       -4      0       0       0       0       0
        0       0       #       RecrDist_GP_1
0       0       0       0       -1      0       -4      0       0       0       0       0
        0       0       #       RecrDist_Area_1
0       0       0       0       -1      0       -4      0       0       0       0       0
        0       0       #       RecrDist_Seas_1
0       0       0       0       -1      0       -4      0       0       0       0       0
        0       0       #       CohortGrowDev
#_seasonal_effects_on_biology_parms
        0       0       0       0       0       0       0       0       0       0
        #_femwtlen1,femwtlen2,mat1,mat2,fec1,fec2,Malewtlen1,malewtlen2,L1,K
3       #_SR_function
#_LO    HI      INIT    PRIOR   PR_type SD      PHASE
1 31 11.1 11 -1 10 3  # SR_R0
0.25 0.99 0.85 0.8  0 0.093 3 # SR_steep
0       2       0.01    0.8     -1      0.8     -4      #       SR_sigmaR
-5      5       0.1     0       -1      1       -3      #       SR_envlink
-5      5       0       0       -1      1       -4      #       SR_R1_offset
0       0       0       0       -1      0       -99     #       SR_autocorr
0       #_SR_env_link
0       #_SR_env_target_0=none;1=devs;_2=R0;_3=steepness
0       #do_recdev:     0=none; 1=devvector;    2=simple        deviations
```

```
2010    # first year of main recr_devs
2010    # last year of main recr_devs
-2      #_recdev phase
1       # (0/1) to read 13 advanced options
0       #_recdev_early_start (0=none; neg value makes relative to recdev_start)
-4      #_recdev_early_phase
1       #_forecast_recruitment
1       #_lambda for fore_recr_like occurring before endyr+1
1990    #_last_early_yr_nobias_adj_in_MPD
1999    #_first_yr_fullbias_adj_in_MPD
2000    #_last_yr_fullbias_adj_in_MPD
2010    #_first_recent_yr_nobias_adj_in_MPD
1.0     #_max_bias_adj_in_MPD
-5      #min rec_dev
5       #max rec_dev
0       #_read_recdevs
#Fishing Mortality info
0.3 # F ballpark for tuning early phases
-2001 # F ballpark year (neg value to disable)
1 # F_Method:  1=Pope; 2=instan. F; 3=hybrid (hybrid is recommended)
0.9 # max F or harvest rate, depends on F_Method
# no additional F input needed for Fmethod 1
# if Fmethod=2; read overall start F value; overall phase; N detailed inputs to read
# if Fmethod=3; read N iterations for tuning for Fmethod 3
#4  # N iterations for tuning F in hybrid method (recommend 3 to 7)
#
#_initial_F_parms
#_LO HI INIT PRIOR PR_type SD PHASE
 0 1 0 0.01 0 99 -1 # InitF_1FISHERY1
#
#_Q_setup
 # Q_type options:  <0=mirror, 0=median_float, 1=mean_float, 2=parameter, 3=parm_w_random_dev, 4=parm_w_randwalk,
5=mean_unbiased_float_assign_to_parm
 #_Den-dep  env-var  extra_se  Q_type
 0 0 0 0 # 1 FISHERY1
 0 0 1 0 # 2 SURVEY1
 0 0 1 0 # 2 SURVEY1
 0 0 1 0 # 2 SURVEY1

#_Cond 0 #_If q has random component, then 0=read one parm for each fleet with random q; 1=read a parm for each year of index
#_Q_parms(if_any)
# LO HI INIT PRIOR PR_type SD PHASE
0 5 0.01 0.01 0 99 1 # InitF_1FISHERY1
0 5 0.01 0.01 0 99 1 # InitF_1FISHERY1
0 5 0.01 0.01 0 99 1 # InitF_1FISHERY1
#_size_selex_types
#_Pattern Discard Male Special
 1 0 0 0 # 1 FISHERY1
 1 0 0 0 # 2 SURVEY1
 1 0 0 0 # 2 SURVEY1
 1 0 0 0 # 2 SURVEY1

#_age_selex_types
#_Pattern ___ Male Special
 10 0 0 0 # 1 FISHERY1
 10 0 0 0 # 2 SURVEY1
 10 0 0 0 # 2 SURVEY1
 10 0 0 0 # 2 SURVEY1
#_LO HI INIT PRIOR PR_type SD PHASE env-var use_dev dev_minyr dev_maxyr dev_stddev Block Block_Fxn
 0 40 35.17 5 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_1P_1_FISHERY1
 0 40 7.511324 24 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_1P_2_FISHERY1
 0 40 35.17 5 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_1P_1_FISHERY1
 0 40 7.511324 24 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_1P_2_FISHERY1
 0 40 35.17 5 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_1P_1_FISHERY1
 0 40 7.511324 24 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_1P_2_FISHERY1
 0 40 35.17 5 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_1P_1_FISHERY1
 0 40 7.511324 24 -1 99 -1 0 0 0 0 0 0 0 # AgeSel_1P_2_FISHERY1
# Tag loss and Tag reporting parameters go next
0  # TG_custom:  0=no read; 1=read if tags exist
0 #_Variance_adjustments_to_input_values
```

1 #_maxlambdaphase
1 #_sd_offset
#
0 # number of changes to make to default Lambdas (default value is 1.0)
999

Starter file

REX_data.ss
REX_control.ss
0 # 0=use init values in control file; 1=use ss3.par
0 # run display detail (0,1,2)
0 # detailed age-structured reports in REPORT.SSO (0,1)
1 # write detailed checkup.sso file (0,1)
4 # write parm values to ParmTrace.sso (0=no,1=good,active; 2=good,all; 3=every_iter,all_parms; 4=every,active)
1 # write to cumreport.sso (0=no,1=likeandtimeseries; 2=add survey fits)
1 # Include prior_like for non-estimated parameters (0,1)
1 # Use Soft Boundaries to aid convergence (0,1) (recommended)
1 # Number of bootstrap datafiles to produce
6 # Turn off estimation for parameters entering after this phase
1 # MCeval burn interval
1 # MCeval thin interval
0.5 # jitter initial parm value by this fraction
-1 # min yr for sdreport outputs (-1 for styr)
-2 # max yr for sdreport outputs (-1 for endyr; -2 for endyr+Nforecastyrs
0 # N individual STD years
0.0001 # final convergence criteria (e.g., 1.0e-04)
0 # retrospective year relative to end year (e.g., -4)
0 # min age for calc of summary biomass
1 # Depletion basis: denom is: 0=skip; 1=rel X*B0; 2=rel X*Bmsy; 3=rel X*B_styr
1 # Fraction (X) for Depletion denominator (e.g., 0.4)
1 # SPR_report_basis: 0=skip; 1=(1-SPR)/(1-SPR_tgt); 2=(1-SPR)/(1-SPR_MSY); 3=(1-SPR)/(1-SPR_Btarget); 4=rawSPR
3 # F_report_units: 0=skip; 1=exploitation(Bio); 2=exploitation(Num); 3=sum(Frates)
0 # F_report_basis: 0=raw; 1=F/Fspr; 2=F/Fmsy ; 3=F/Fbtgt
999 # check value for end of file

Forecast file

1 # Benchmarks: 0=skip; 1=calc F_spr,F_btgt,F_msy
2 # MSY: 1= set to F(SPR); 2=calc F(MSY); 3=set to F(Btgt); 4=set to F(endyr)
0.3 # SPR target (e.g., 0.40)
0.25 # Biomass target (e.g., 0.40)
#_Bmark_years: beg_bio, end_bio, beg_selex, end_selex, beg_relF, end_relF (enter actual year, or values of 0 or -integer to be rel. endyr)
 0 0 0 0 0 0
2010 2010 2010 2010 2010 2010 # after processing
1 #Bmark_relF_Basis: 1 = use year range; 2 = set relF same as forecast below
#
1 # Forecast: 0=none; 1=F(SPR); 2=F(MSY) 3=F(Btgt); 4=Ave F (uses first-last relF yrs); 5=input annual F scalar
12 # N forecast years
0.2 # F scalar (only used for Do_Forecast==5)
#_Fcast_years: beg_selex, end_selex, beg_relF, end_relF (enter actual year, or values of 0 or -integer to be rel. endyr)
 0 0 0 0
2010 2010 2010 2010 # after processing
1 # Control rule method (1=catch=f(SSB) west coast; 2=F=f(SSB))
0.25 # Control rule Biomass level for constant F (as frac of Bzero, e.g., 0.40); (Must be > the no F level below)
0.05 # Control rule Biomass level for no F (as frac of Bzero, e.g., 0.10)
1 # Control rule target as fraction of Flimit (e.g., 0.75)
3 #_N forecast loops (1=OFL only; 2=ABC; 3=get F from forecast ABC catch with allocations applied)
3 #_First forecast loop with stochastic recruitment
0 #_Forecast loop control #3 (reserved for future bellsandwhistles)
0 #_Forecast loop control #4 (reserved for future bellsandwhistles)
0 #_Forecast loop control #5 (reserved for future bellsandwhistles)
2013 #FirstYear for caps and allocations (should be after years with fixed inputs)
0 # stddev of log(realized catch/target catch) in forecast (set value>0.0 to cause active impl_error)
0 # Do West Coast gfish rebuilder output (0/1)
2013 # Rebuilder: first year catch could have been set to zero (Ydecl)(-1 to set to 1999)
2013 # Rebuilder: year for current age structure (Yinit) (-1 to set to endyear+1)
1 # fleet relative F: 1=use first-last alloc year; 2=read seas(row) x fleet(col) below
Note that fleet allocation is used directly as average F if Do_Forecast=4

```
2 # basis for fcast catch tuning and for fcast catch caps and allocation  (2=deadbio; 3=retainbio; 5=deadnum; 6=retainnum)
# Conditional input if relative F choice = 2
# Fleet relative F:  rows are seasons, columns are fleets
#_Fleet:  FISHERY
#  1
# max totalcatch by fleet (-1 to have no max) must enter value for each fleet
 -1
# max totalcatch by area (-1 to have no max); must enter value for each fleet
 -1
# fleet assignment to allocation group (enter group ID# for each fleet, 0 for not included in an alloc group)
 0
#_Conditional on >1 allocation group
# allocation fraction for each of: 0 allocation groups
# no allocation groups
2 # Number of forecast catch levels to input (else calc catch from forecast F)
3 # basis for input Fcast catch:  2=dead catch; 3=retained catch; 99=input Hrate(F) (units are from fleetunits; note new codes in
SSV3.20)
# Input fixed catch values
#Year Seas Fleet Catch(or_F)
 2013 1 1 454.7
 2014 1 1 454.7
999 # verify end of input
```

Appendix B. XDB-SRA Files

Appendix B.1. Brown rockfish

Catch (Total Removals, mt)

catch.mt	year
9.2	1916
14.3	1917
16.7	1918
11.6	1919
11.9	1920
9.8	1921
8.4	1922
9.1	1923
5.3	1924
7.6	1925
9.6	1926
4.3	1927
5.7	1928
5.4	1929
10.5	1930
13.8	1931
14.3	1932
15.8	1933
11.2	1934
14.4	1935
15.0	1936
17.0	1937
18.3	1938
20.1	1939
22.3	1940
22.0	1941
6.7	1942
8.7	1943
5.6	1944
12.2	1945
23.0	1946
14.0	1947
22.5	1948
29.8	1949
30.2	1950
46.1	1951
46.6	1952
37.1	1953
50.9	1954
99.2	1955
106.3	1956
108.6	1957
129.4	1958
91.0	1959
106.3	1960
85.3	1961
92.2	1962
116.4	1963
94.2	1964
119.6	1965
136.2	1966
150.3	1967
156.4	1968

126.9	1969	
161.5	1970	
161.2	1971	
212.7	1972	
310.4	1973	
360.0	1974	
313.7	1975	
334.4	1976	
284.8	1977	
202.7	1978	
196.3	1979	
412.8	1980	
141.2	1981	
260.3	1982	
139.6	1983	
237.2	1984	
217.6	1985	
267.1	1986	
190.2	1987	
319.6	1988	
213.3	1989	
172.9	1990	
170.4	1991	
142.1	1992	
137.8	1993	
76.1	1994	
76.6	1995	
106.8	1996	
154.3	1997	
98.3	1998	
125.8	1999	
101.5	2000	
151.8	2001	
94.5	2002	
169.3	2003	
58.2	2004	
100.4	2005	
89.2	2006	
76.1	2007	
72.6	2008	
84.9	2009	
97.0	2010	
112.7	2011	
94.7	2012	
101.5	2013	# avg. 2010-2012
101.5	2014	# avg. 2010-2012
151.3	2015	# 40-10 adjusted catch, Pstar 0.45

Central CA CPFV Onboard Observer Index for Brown Rockfish

year	index	logSD
1988	0.34239806	0.200382572
1989	0.32699359	0.180369023
1990	0.37656108	0.323948708
1991	0.41192106	0.455332767
1992	0.26781914	0.18660012
1993	0.29231143	0.25586476
1994	0.19116646	0.241869417
1995	0.32258103	0.238588218
1996	0.2601924	0.210312235
1997	0.1564559	0.200791654
1998	0.3721465	0.166187027
1999	0.13321081	0.513543014
2001	0.20608263	0.251495715
2002	0.09451003	0.34102123
2003	0.28144315	0.140344282
2004	0.31042538	0.129845183
2005	0.3096305	0.160046124
2006	0.51170771	0.127220295
2007	0.44385928	0.140763331
2008	0.29668747	0.203527786
2009	0.41620333	0.188783909
2010	0.35673849	0.116790411
2011	0.31699517	0.133431094

Southern CA CPFV Onboard Observer Index for Brown Rockfish

year	index	logSD
1999	0.008914224	0.364606051
2000	0.005468816	0.401970843
2001	0.007865838	0.388155065
2002	0.02288711	0.210903267
2003	0.029912146	0.202572065
2004	0.019347095	0.241814764
2005	0.036638665	0.164697497
2006	0.085673157	0.123720645
2007	0.054971952	0.138601482
2008	0.081503421	0.119140761
2009	0.064696945	0.108417821
2010	0.08261015	0.112313676
2011	0.057716836	0.153526767

Central CA RecFIN Dockside Observer Index for Brown Rockfish

year	index	logSD
1980	0.19340974	0.390437534
1981	0.09921671	0.52650861
1983	1.02295082	0.59012895
1984	0.12287234	0.569648147
1985	0.1421709	0.237359448
1986	0.39063355	0.30293007
1987	0.24796126	0.556820189
1988	0.33268108	0.935793124
1989	0.04758128	0.528850078
1993	0.14525133	0.727062236
1994	0.03639847	0.826638216
1996	0.08476253	0.252058272
1999	0.1369259	0.51629563
2000	0.09565217	0.436424928
2001	0.11541137	0.245042617
2002	0.06203304	0.217282044
2003	0.1604449	0.276676775

Southern CA RecFIN Dockside Observer Index for Brown Rockfish

year	index	logSD
1980	0.020053821	0.523284
1981	0.021804458	0.9573383
1982	0.0353475	0.9598115
1983	0.010590486	0.5297299
1984	0.016735148	0.4476916
1985	0.009591447	0.4137208
1986	0.002267574	0.6843325
1988	0.006654568	0.4892862
1994	0.012811162	0.8014592
1996	0.003915139	0.717811
1998	0.007886473	0.4537797
1999	0.019178731	0.5172163
2000	0.022102944	0.6066723
2001	0.04481261	0.5026588
2002	0.019180274	0.4161548
2003	0.030154548	0.5445968

XDB-SRA Control File for Brown Rockfish

sci.name	Sebastes crameri
common.name	Brown Rockfish
species.code	BRWN
age.mat	4
delta.yr	2000
current.yr	2013
DBSRA.OFL.yr	2015
M.est	0.14
SD.lnM	0.4
FMSYtoMratio	0.97
SD.FMSYtoMratio	0.46
Delta	0.7
SD.Delta	0.2
DeltaLowerBound	0.01
DeltaUpperBound	0.99
BMSYtoB0ratio	0.4
SD.BMSYtoB0ratio	0.15
BMSYtoB0LowerBound	0.05
BMSYtoB0UpperBound	0.95
random.seed	1705

Appendix B.2. China rockfish, South of Cape Mendocino

Catch (Total Removals, mt)

catch.mt	year
6.5	1916
10.1	1917
11.9	1918
8.2	1919
8.4	1920
6.9	1921
6.0	1922
6.5	1923
3.7	1924
4.7	1925
7.5	1926
6.4	1927
8.2	1928
7.2	1929
10.0	1930
5.1	1931

11.5	1932
5.5	1933
10.1	1934
9.5	1935
9.8	1936
9.6	1937
7.7	1938
5.4	1939
5.5	1940
5.1	1941
2.8	1942
3.8	1943
2.1	1944
2.7	1945
5.3	1946
4.6	1947
9.4	1948
12.4	1949
11.3	1950
13.8	1951
12.1	1952
10.6	1953
11.0	1954
12.6	1955
13.9	1956
14.2	1957
22.7	1958
18.1	1959
15.1	1960
14.7	1961
12.6	1962
16.0	1963
10.1	1964
17.0	1965
18.9	1966
24.3	1967
21.1	1968
23.2	1969
37.3	1970
27.1	1971
39.2	1972
50.3	1973
49.5	1974
48.0	1975
52.1	1976
47.8	1977
33.3	1978
44.4	1979
59.2	1980
36.3	1981
47.0	1982
24.2	1983
25.0	1984
30.6	1985
43.9	1986
59.3	1987
42.9	1988
38.3	1989
36.4	1990
40.4	1991
49.3	1992
41.7	1993

61.9	1994	
46.6	1995	
33.9	1996	
39.0	1997	
19.0	1998	
21.2	1999	
20.6	2000	
19.1	2001	
18.1	2002	
17.6	2003	
9.9	2004	
15.9	2005	
12.8	2006	
13.5	2007	
15.3	2008	
20.3	2009	
18.9	2010	
15.7	2011	
13.6	2012	
16.1	2013	# avg. 2010-2012
16.1	2014	# avg. 2010-2012
50.4	2015	# 40-10 adjusted catch, Pstar 0.45

Southern and Central CA RecFIN Dockside Observer Index for China Rockfish

year	index	logSD
1980	0.0327	0.404235796
1981	0.0498	0.747530915
1983	0.0592	0.421544477
1984	0.0137	0.514363007
1985	0.0253	0.31911839
1986	0.0496	0.330684643
1987	0.0486	0.428309101
1988	0.0584	0.363905742
1989	0.0669	0.409595198
1993	0.0143	0.630114726
1994	0.018	0.412401021
1995	0.1076	0.232772535
1996	0.0449	0.148121036
1999	0.0302	0.23338366
2000	0.0304	0.26246385
2001	0.0698	0.206670473
2002	0.0801	0.181523255
2003	0.0607	0.167036666

Central CA CPFV Onboard Observer Index for China Rockfish

year	index	logSD
1988	0.0512	0.169
1989	0.052	0.168
1990	0.117	0.225
1991	0.0733	0.293
1992	0.0409	0.175
1993	0.0461	0.186
1994	0.0731	0.147
1995	0.0456	0.191
1996	0.0522	0.157
1997	0.0375	0.188
1998	0.0186	0.228
1999	0.0429	0.294
2001	0.0328	0.273
2002	0.0544	0.268
2003	0.0671	0.184
2004	0.0594	0.167

2005	0.0565	0.237
2006	0.0518	0.214
2007	0.0737	0.183
2008	0.0674	0.193
2009	0.1014	0.178
2010	0.0878	0.171
2011	0.064	0.166

XDB-SRA Control File for China Rockfish, South of Cape Mendocino

sci.name	Sebastes nebulosus
common.name	China Rockfish
species.code	CHNA
age.mat	5
current.yr	2013
delta.yr	2000
DBSRA.OFL.yr	2013
M.est	0.06
SD.lnM	0.4
FMSYtoMratio	0.97
SD.FMSYtoMratio	0.46
Delta	0.7
SD.Delta	0.2
DeltaLowerBound	0.01
DeltaUpperBound	0.99
BMSYtoB0ratio	0.4
SD.BMSYtoB0ratio	0.15
BMSYtoB0LowerBound	0.05
BMSYtoB0UpperBound	0.95
random.seed	824

Appendix B.3. China rockfish, North of Cape Mendocino

Catch (Total Removals, mt)

catch.mt	year
0.0	1916
0.0	1917
0.0	1918
0.0	1919
0.0	1920
0.0	1921
0.0	1922
0.0	1923
0.0	1924
0.0	1925
0.0	1926
0.0	1927
0.0	1928
0.1	1929
0.1	1930
0.1	1931
0.0	1932
0.1	1933
0.8	1934
0.6	1935
1.0	1936
0.8	1937
2.6	1938
4.7	1939
3.0	1940
1.0	1941
0.8	1942
0.4	1943
0.4	1944
0.5	1945
0.6	1946
0.3	1947
0.5	1948
0.4	1949
0.3	1950
0.3	1951
0.3	1952
0.1	1953
0.1	1954
0.2	1955
0.2	1956
0.4	1957
0.1	1958
0.1	1959
0.1	1960
0.3	1961
0.3	1962
0.5	1963
0.5	1964
0.9	1965
0.9	1966
1.4	1967
1.5	1968
2.5	1969
2.0	1970
3.0	1971
3.5	1972

4.5	1973	
5.7	1974	
4.2	1975	
5.0	1976	
5.2	1977	
7.2	1978	
9.9	1979	
10.7	1980	
10.4	1981	
10.6	1982	
9.1	1983	
8.9	1984	
6.9	1985	
7.3	1986	
8.7	1987	
7.9	1988	
11.9	1989	
17.6	1990	
10.4	1991	
15.6	1992	
12.6	1993	
17.5	1994	
18.0	1995	
15.8	1996	
22.0	1997	
27.3	1998	
35.5	1999	
22.0	2000	
28.0	2001	
29.0	2002	
16.5	2003	
12.0	2004	
9.4	2005	
11.1	2006	
15.4	2007	
16.3	2008	
15.1	2009	
11.8	2010	
16.4	2011	
17.3	2012	
15.2	2013	# avg. 2010-2012
15.2	2014	# avg. 2010-2012
6.2	2015	# 40-10 adjusted catch, Pstar 0.45

Northern CA and OR RecFIN Dockside Observer Index for China Rockfish

year	index	logSD
1980	0.1014	0.515
1981	0.059	0.263
1982	0.0441	0.642
1983	0.0193	0.65
1984	0.0192	0.366
1985	0.06	0.373
1986	0.0242	0.533
1987	0.0684	0.47
1988	0.0407	0.29
1989	0.031	0.358
1993	0.0437	0.3
1994	0.0404	0.257
1995	0.0252	0.291
1996	0.0244	0.332
1997	0.0374	0.245
1998	0.0277	0.222
1999	0.0423	0.179
2000	0.0431	0.272
2001	0.0138	0.464
2002	0.0156	0.34
2003	0.0271	0.472

OR CPFV Onboard Observer Index for China Rockfish

year	index	logSD
2001	0.0299	0.268
2003	0.0298	0.239
2004	0.019	0.335
2005	0.0135	0.35
2006	0.0177	0.291
2007	0.0346	0.212
2008	0.0176	0.275
2009	0.0287	0.248
2010	0.007	0.508
2011	0.0217	0.444
2012	0.0335	0.269

XDB-SRA Control File for China Rockfish, North of Cape Mendocino

sci.name	Sebastes nebulosus
common.name	China Rockfish
species.code	CHNA
age.mat	5
current.yr	2013
delta.yr	2000
DBSRA.OFL.yr	2013
M.est	0.06
SD.lnM	0.4
FMSYtoMratio	0.97
SD.FMSYtoMratio	0.46
Delta	0.7
SD.Delta	0.2
DeltaLowerBound	0.01
DeltaUpperBound	0.99
BMSYtoB0ratio	0.4
SD.BMSYtoB0ratio	0.15
BMSYtoB0LowerBound	0.05
BMSYtoB0UpperBound	0.95
random.seed	824

Appendix B.4. Copper rockfish, South of Point Conception

Catch (Total Removals, mt)

catch.mt	year
0.1	1916
0.2	1917
0.2	1918
0.1	1919
0.1	1920
0.1	1921
0.1	1922
0.1	1923
0.2	1924
0.2	1925
0.3	1926
0.2	1927
0.2	1928
0.2	1929
0.3	1930
0.3	1931
0.3	1932
0.2	1933
0.3	1934
0.6	1935
0.4	1936
1.2	1937
0.7	1938
0.5	1939
0.5	1940
0.6	1941
0.1	1942
0.2	1943
0.1	1944
0.2	1945
0.2	1946
0.7	1947
1.8	1948
2.3	1949
3.2	1950
5.9	1951
4.5	1952
4.1	1953
8.6	1954
16.7	1955
18.3	1956
10.8	1957
10.9	1958
5.9	1959
6.8	1960
9.7	1961
6.6	1962
7.0	1963
11.8	1964
17.4	1965
43.8	1966
50.7	1967
59.3	1968
47.0	1969
69.6	1970
66.8	1971
92.2	1972

111.5	1973	
138.2	1974	
142.2	1975	
116.9	1976	
109.1	1977	
108.1	1978	
151.8	1979	
363.9	1980	
120.4	1981	
224.7	1982	
117.2	1983	
131.3	1984	
167.2	1985	
141.6	1986	
16.2	1987	
74.7	1988	
71.6	1989	
57.6	1990	
50.9	1991	
32.6	1992	
19.9	1993	
62.8	1994	
51.0	1995	
98.0	1996	
43.9	1997	
55.7	1998	
62.4	1999	
27.4	2000	
20.6	2001	
14.6	2002	
17.0	2003	
16.3	2004	
30.2	2005	
13.5	2006	
30.2	2007	
26.5	2008	
25.1	2009	
23.8	2010	
44.9	2011	
50.2	2012	
39.6	2013	# avg. 2010-2012
39.6	2014	# avg. 2010-2012
152.4	2015	# 40-10 adjusted catch, Pstar 0.45

Southern CA CPFV Onboard Observer Index for Copper Rockfish

year	index	logSD
1999	0.0347026	0.202422714
2000	0.04834209	0.274588269
2001	0.01031578	0.373874588
2002	0.01672497	0.254170138
2003	0.04291353	0.181850041
2004	0.025317	0.195058676
2005	0.05667028	0.162540492
2006	0.06549364	0.127044834
2007	0.10506016	0.104773315
2008	0.08477663	0.097434553
2009	0.06114999	0.120248399
2010	0.05530523	0.110006798
2011	0.08151317	0.096205046

Southern CA RecFIN Dockside Observer Index for Copper Rockfish

year	index	logSD
1980	0.08374128	0.385044159
1981	0.04934085	0.3743977
1982	0.0291001	0.619788449
1983	0.11078686	0.604208127
1984	0.09522736	0.444209452
1985	0.04527815	0.424033134
1986	0.08328542	0.459150935
1988	0.16267752	0.613231574
1993	0.08325661	0.529162455
1994	0.08350039	0.980984905
1995	0.06296092	0.61486449
1996	0.13282901	0.323678637
1997	0.07748774	0.960291868
1998	0.0885108	0.40754817
1999	0.1479035	0.254902986
2000	0.09307187	0.456695668
2001	0.08665951	0.383998641
2002	0.07425175	0.232851561
2003	0.1612675	0.409675572

XDB-SRA Control File for Copper Rockfish, South of Point Conception

sci.name	Sebastes caurinus
common.name	Copper Rockfish
species.code	COPP
age.mat	6
delta.yr	2000
current.yr	2013
DBSRA.OFL.yr	2013
M.est	0.09
SD.lnM	0.4
FMSYtoMratio	0.97
SD.FMSYtoMratio	0.46
Delta	0.7
SD.Delta	0.2
DeltaLowerBound	0.01
DeltaUpperBound	0.99
BMSYtoB0ratio	0.4
SD.BMSYtoB0ratio	0.15
BMSYtoB0LowerBound	0.05
BMSYtoB0UpperBound	0.95
random.seed	824

Appendix B.5. Copper rockfish, North of Point Conception

Catch (Total Removals, mt)

catch.mt	year
4.1	1916
6.4	1917
7.8	1918
5.1	1919
5.2	1920
4.5	1921
3.8	1922
4.0	1923
2.7	1924
4.0	1925
5.1	1926
3.8	1927
5.4	1928

6.4	1929
9.3	1930
11.4	1931
11.9	1932
12.3	1933
12.2	1934
15.6	1935
16.4	1936
19.2	1937
18.4	1938
16.5	1939
21.3	1940
20.4	1941
10.1	1942
11.0	1943
15.6	1944
30.8	1945
39.4	1946
18.8	1947
32.7	1948
34.7	1949
39.6	1950
54.4	1951
45.6	1952
36.5	1953
47.2	1954
52.7	1955
60.4	1956
58.6	1957
99.5	1958
80.6	1959
68.7	1960
51.5	1961
64.0	1962
79.8	1963
71.2	1964
105.8	1965
121.9	1966
129.7	1967
137.2	1968
147.7	1969
182.4	1970
171.2	1971
217.7	1972
249.2	1973
274.2	1974
270.3	1975
299.5	1976
309.0	1977
285.0	1978
295.8	1979
117.4	1980
400.4	1981
220.6	1982
175.6	1983
144.8	1984
160.0	1985
124.7	1986
102.1	1987
96.9	1988
108.1	1989
123.3	1990

130.1	1991	
152.4	1992	
149.4	1993	
83.7	1994	
70.6	1995	
89.3	1996	
91.6	1997	
60.8	1998	
54.6	1999	
39.8	2000	
35.8	2001	
28.2	2002	
28.3	2003	
23.2	2004	
41.2	2005	
43.1	2006	
48.6	2007	
38.9	2008	
45.7	2009	
34.4	2010	
35.6	2011	
44.9	2012	
38.3	2013	# avg. 2010-2012
38.3	2014	# avg. 2010-2012
132.3	2015	# 40-10 adjusted catch, Pstar 0.45

Central CA CPFV Onboard Observer Index for Copper Rockfish

year	index	logSD
1988	0.0397	0.142
1989	0.0597	0.119
1990	0.0724	0.2
1991	0.0468	0.223
1992	0.0686	0.121
1993	0.0697	0.125
1994	0.0495	0.133
1995	0.0603	0.125
1996	0.0576	0.121
1997	0.0604	0.127
1998	0.0552	0.152
1999	0.0403	0.409
2001	0.1001	0.219
2002	0.0545	0.374
2003	0.0736	0.199
2004	0.0939	0.117
2005	0.1555	0.124
2006	0.1497	0.11
2007	0.1309	0.117
2008	0.0764	0.164
2009	0.0705	0.179
2010	0.137	0.113
2011	0.1029	0.124

Central/Northern CA and OR RecFIN Dockside Observer Index for Copper Rockfish

year	index	logSD
1980	0.0344263	0.437861772
1981	0.11580617	0.38704024
1982	0.04417949	0.451436183
1983	0.11141602	0.348087994
1984	0.12819123	0.449678658
1985	0.0555466	0.337609966
1986	0.09774667	0.219435546
1987	0.02798718	1.155683336

1988	0.02755241	0.359211559
1989	0.08905342	0.250402589
1993	0.06030649	0.280590726
1994	0.05983713	0.285738388
1995	0.02109752	0.471002191
1996	0.05212757	0.125912001
1997	0.0479666	0.308124197
1998	0.04245647	0.385537868
1999	0.05072293	0.153286935
2000	0.05042611	0.316376639
2001	0.041476	0.219157638
2002	0.03737898	0.303376218
2003	0.02508151	0.209186744

OR CPFV Onboard Observer Index for Copper Rockfish

year	index	logSD
2001	0.0264	0.34
2003	0.0147	0.357
2004	0.0118	0.406
2005	0.0387	0.301
2006	0.0384	0.257
2007	0.0304	0.234
2008	0.0149	0.316
2009	0.0316	0.284
2010	0.0406	0.297
2011	0.0137	0.484
2012	0.023	0.354

XDB-SRA Control File for Copper Rockfish, North of Point Conception

sci.name	Sebastes caurinus
common.name	Copper Rockfish
species.code	COPP
age.mat	6
delta.yr	2000
current.yr	2013
DBSRA.OFL.yr	2013
M.est	0.09
SD.lnM	0.4
FMSYtoMratio	0.97
SD.FMSYtoMratio	0.46
Delta	0.7
SD.Delta	0.2
DeltaLowerBound	0.01
DeltaUpperBound	0.99
BMSYtoB0ratio	0.4
SD.BMSYtoB0ratio	0.15
BMSYtoB0LowerBound	0.05
BMSYtoB0UpperBound	0.95
random.seed	824

Appendix C. Partitioning OFLs for brown and copper rockfish

During the STAR Panel, the STAT presented regional models for brown rockfish and copper rockfish (north and south of Point Conception). The Panel recommended that the OFL for brown rockfish be based on the coastwide model, partitioned into areas north and south of Point Conception based on the regional models. The Panel considered the regional models for copper rockfish to be adequate for OFL determination. However, the assessments for brown rockfish (coastwide) and copper rockfish (north of Point Conception, CA) span the boundary between the PFMC's northern and southern rockfish complexes (40° 10′ N lat., roughly near Cape Mendocino). This appendix describes possible methods to partition the OFL estimate into northern and southern components.

When regional assessments are not available, partitioning of OFLs would ideally involve taking the product of density and habitat area to arrive at an estimate of abundance (or relative abundance) in each management area. The STAT considered using estimates of habitat area derived from recreational catch observations (see section 2.1.6.2), combined with a proxy for density (CPUE) derived from recreational catch data. In the end, this approach was not possible for copper rockfish because the STAT did not have CPUE and habitat information off Washington, which is needed to create a complete estimate of relative abundance north of Cape Mendocino. The density of brown rockfish in Washington is effectively zero, but catch rates north of Cape Mendocino are so low that an analysis based on detailed habitat area estimates and catch rates is unlikely to differ significantly from a simpler, catch-based approach.

Appendix C.1. Brown rockfish

To partition the OFL for brown rockfish, we used regional assessments to estimate median vulnerable biomass levels in 2015 assuming recent average catch in 2013-14. Vulnerable biomass estimates in 2015 were 381.6 mt south of Point Conception and 1082.3 mt north of Point Conception. Approximately 26.1% (381.6 / (381.6+1082.3)) of coastwide brown rockfish biomass in 2013 is south of Point Conception. Dick and MacCall (2010, their Table 65) developed a catch-based allocation of OFL, finding that 2.6% of coastwide brown rockfish biomass is north of Cape Mendocino. The remaining percentage (biomass in central California) is therefore 71.3% of coastwide biomass. Applying these percentages to the median OFL in 2015 from the coastwide brown rockfish assessment (164 mt) provides regional estimates of OFL (Table B1).

Table B1. Brown rockfish OFLs for 2015, by region

	% of coastwide OFL	OFL (mt)
Southern CA	26.1%	42.8
Central CA	71.3%	116.9
South of 40° 10′ N lat. (South + Central)	97.4%	159.7
North of 40° 10′ N lat.	2.6%	4.3

Appendix C.2. Copper rockfish

We apply a similar method to that used for brown rockfish (above), but based on regional model OFLs (per the STAR Panel's recommendation). We estimated median vulnerable biomass levels in 2015 assuming recent average catch in 2013-14. Vulnerable biomass estimates in 2015 were 1420 mt south of Point Conception and 1691.2 mt north of Point Conception. Approximately 45.6% (1420 / (1420+1691.2)) of coastwide copper rockfish biomass in 2013 is south of Point Conception. The large fraction of biomass estimated for southern California is influenced by the recent increases in biomass in that area, relative to the central/northern stock. Dick and MacCall (2010, their Table 65) developed a catch-based allocation of OFL, finding that 15.5% of coastwide copper rockfish biomass is north of Cape Mendocino. The remaining percentage (biomass in central California) is therefore 38.6% of coastwide biomass. Using the percentages for central California (38.9%) and the area north of Cape Mendocino (15.5%), we estimate that 28.5% (15.5 / (15.5+38.9)) of the central/northern copper rockfish OFL estimate for 2015 should be allocated north of Cape Mendocino (Table B2).

Table B2. Copper rockfish OFLs ,by region, using catch-based allocation method

	Source	2015 OFL (mt)
South of Conception	model median estimate	165
North of Conception	model median estimate	144
Coastwide	(sum of regional models)	309
North of 40° 10′ N lat.	Northern OFL * 0.285	41.0
South of 40° 10′ N lat.	309 – 41	268